COMPASS

perspectives & tools to benefit southern forest resources

issue 6

CAN WE BRING THE BIG WOODS BACK TO THE LOWER MISSISSIPPI VALLEY?

Southern Research Station

USDA Forest Service

inside...
the science

Cover Photo: Workers carrying bags full of dormant tree saplings, mostly oaks, fan out to plant a former agricultural field in the Lower Mississippi Alluvial Valley. (photo by Emile Gardiner)

COMPASS

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perspectives and tools to benefit southern forest resources

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The Big Woods of the Lower Mississippi Alluvial Valley

"Mississippi: The rich deep black alluvial soil which would grow cotton taller than the head of a man on a horse, already one jungle one brake one impassable density of brier and cane and vine interlocking the soar of gum and cypress and hickory and pinoak and ash, printed now by the tracks of unalien shapes—bear and deer and panthers and bison and wolves and alligators and the myriad smaller beasts . . . ." William Faulkner, *The Big Woods*.

By the time William Faulkner wrote *The Big Woods* in the 1930s, the land the book's stories were set in had already been largely deforested to plant cotton. Throughout *The Big Woods*, whose longest story "The Bear" chronicles loss at so many levels, Faulkner mourns for the remnants of the Big Woods he finds crowded into the Vs formed by hills and the Mississippi River, remains of a vast hardwood thicket that once stretched 25 million acres across the Lower Mississippi Valley. Faulkner knew that it all came down to economics:

"Sometimes it would seem to him that the three of them—himself, the old hunter, and the hills and the vast River—had presided over a cycle; or rather, not a cycle but a mad and pointless merry-go-round, with the two of them anyway—the inviolable hills and the great invincible almost inattentive River—impervious to it: the timber which had to be logged and sold in order to deforest the land in order to convert the soil to raising cotton in order to sell the cotton in order to make the land valuable enough to be worth spending money raising dykes to keep the River off of it."

The question today is how to make that land valuable enough to grow trees on it again, to bring back the region's rich biological diversity, to clean water, and to reduce the flooding and runoff that wash sediments into the Gulf of Mexico. In this issue of *Compass*, we will look at efforts to restore the Big Woods and its rich ecology of plant, bird, bear, fish, mussel—and human—to the Lower Mississippi Alluvial Valley. We will look at history, at the research that underlies restoration, and at the social and economic dimensions that must be addressed if restoration is to be achieved.

Faulkner, William. 1955. The Big Woods. *New York: Random House. 212 p.*

Redgum Natural Area on the Delta National Forest. *(photo by USDA Forest Service)*

CAN WE BRING BACK FAULKNER'S BIG WOODS?

by John Stanturf

Say "deforestation" and the image that springs to mind for most people is the Amazon or some other tropical forest landscape. Few would equate the word with the clearing of the vast temperate forests of the Eastern United States that began with the first European colonists, but this country was founded on exploiting the biological wealth of eastern forests. One of the last wild areas in the East to be cleared for agriculture was the rich alluvial bottomland hardwood forest of the Lower Mississippi River flood plain.

Stretching from present day Cairo, IL, where the Upper Mississippi and Ohio Rivers join, to the beginning of the bird-foot-shaped Delta in southern Louisiana where the mighty Mississippi River ends, the Lower Mississippi Alluvial Valley (LMAV) supported extensive hardwood and deepwater swamp forests. This region of 25 million acres provided habitat for waterfowl and songbirds, the cougar, black bear, red wolf, and bison, snakes and gators—and of course, mosquitoes.

This bottomland hardwood forest was far from static, however. Long before the first humans reached the area, the flood plain of the world's third longest river was shaped by climatic and hydrologic cycles and changes. The fluctuating glacial ice sheets farther north sent pulses of sediment-laden water through the valley, building on the foundation laid down during previous ice ages. When the glaciers began to retreat after reaching their maximum extent about 18,000 years ago, the heavy bed load of rock and soil carried by their meltwater was spread across the flood plain of the lower river in a series of overlapping deposits.

The warmer, drier climate that arrived about 9,000 years ago meant less water and lower energy; the river began to meander, episodically changing course and leaving behind distinct landforms within the flood plain. As the climate changed again during the colder and wetter Little Ice Age that occurred between the 1300s and the mid-1800s, the present distribution of tree species emerged, with groups of species adapted to various levels of flooding depth, duration, and season.

HUMANS ARRIVE ON THE SCENE

The first humans in the area, hunting and gathering Paleoindians, are now thought to have arrived about 16,000 years ago, using the natural levees of the rivers to traverse the watery lowland regions. Natural levees are the higher and drier sites closest to rivers where floodwaters drop their heaviest sediments. In the Lower Mississippi Valley, the natural levees were often covered with giant cane; the first settlements were located on these drier sites where, around 3,000 B.C., settlers began to develop agriculture, domesticating local species such as sumpweed, a relative of the sunflower grown as a grain.

Maize was introduced from Central America about A.D. 400 and farming

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Between the early 1800s and 1935, about one-half of the original bottomland forests of the Lower Mississippi Alluvial Valley were cleared for cotton and other crops. *(photo courtesy of Memphis Room, Memphis/Shelby County Public Library and Information Center)*

FAULKNER'S BIG WOODS

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took on greater importance. Larger areas were cleared, and eventually cities arose. Cahokia, near present day St. Louis, was the largest city of what archaeologists call the Mississippian culture, with a population of 30,000 in A.D. 1250. It was not until 1800 that another city in the United States—Philadelphia—approached this size.

After the DeSoto expedition (1538–41) and before French settlement began in the late 17th century, Native American populations drastically declined due to introduced diseases. The early French settlers in the Lower Mississippi Valley used the bottomlands much as the Native Americans had; they farmed the natural levees and other higher ground first, depending on the watercourses for transportation. Agricultural expansion was impeded by periodic flooding and the need for drainage, formidable obstacles that could only be overcome by arduous manual labor. The earliest attempt at flood control in the Lower Mississippi Valley was at New Orleans in 1717.

During the 18th century, French settlers along both sides of the Mississippi focused on commercial farming, following the plantation model imported from the West Indies. Some scattered settlements were established farther north along the Red and Missouri Rivers by the time the French settlements were secretly ceded to Spain in 1762, but most of the area's population lived between New Orleans and present-day St. Francisville, LA. The Yazoo River Basin in Mississippi remained Indian land.

FOREST CLEARING COMMENCES

The current agricultural economy of the valley was foreshadowed by the introduction of cotton in 1740 and sugar cane in 1751. An early observer riding up the river from New Orleans in 1810 described continuous plantations for 100 miles. The influx of Acadian settlers from Nova Scotia in 1766 to 1768 greatly changed the nature of European settlement in the area. These Cajuns established subsistence farming and hunting and a distinctive culture in the lower valley.

On December 16, 1811, the most severe earthquake recorded in North America occurred along the New Madrid Fault in Missouri. Towns and villages along the Mississippi River in Missouri, Kentucky, and Arkansas were destroyed. Though little property damage was recorded in the sparsely populated Lower Mississippi Alluvial Valley, the landscape was irreparably changed. The river was affected as far south as Vicksburg, where river islands disappeared. Thousands of acres of bottomlands sank from faulting, forming swamps and permanent lakes, including Reelfoot Lake in Tennessee.

Between the early 1800s and 1935, about one-half of the original forests in the LMAV were cleared. Nineteenth century settlers, searching for fertile farmland, cleared forests—starting from the highest and best drained sites, moving lower and away from the rivers into the backswamp areas over time. Following the transfer of sovereignty over the Mississippi Basin to the fledgling United States through the Louisiana Purchase of 1803, migration into the bottomlands increased considerably. A series of treaties with the Choctaw and Chickasaw tribes opened the east bank of the Mississippi River to European settlers. The first white settlers in the Yazoo Basin of Mississippi probably arrived between 1825 and 1827; within 20 years, it became the premier new planting area for cotton in the South.

By 1850, a continuous chain of plantations ran along the Mississippi and its tributary rivers. The interruption of cropping during the Civil War caused much cleared land to revert to forest, and the neglect of levees led to increased flooding. Severe floods in 1862 and 1865 washed away large sections of levees, while military operations damaged others. After the war, local districts were hard pressed financially to maintain the levees. Appeals were often made to the Federal Government, but a Federal flood control act was not passed until 1917; Federal responsibility for flood control was not firmly established until after the devastating flood of 1927.

Rice and Soybeans Take Over

From 1880 through the 1920s, the old-growth pine and cypress forests of the Mississippi Valley were cutover as the South became the center of the timber industry in the United States. Forest clearing in the bottomlands was aided by sales of public land to the expanding railroads, which sought to entice farmers to the unsettled parts of the area, and cut even more wood to fuel their engines. From the beginning to the middle of the 20th century, the LMAV saw new waves of immigration with some new clearing of forest land for agriculture. Farmers from the Lake States and the Corn Belt immigrated especially into the Yazoo Basin from 1907 until after World War I.

New crops such as rice brought new opportunities, beginning in the 1940s. Developing markets in postwar Asia caused an expansion of rice culture into Mississippi and Arkansas. Clearing for soybeans began in the 1950s and extended through the 1970s, extending agriculture into lower lying land that had been considered too wet to be economical. Soybeans have a short growing season—as little as 90 days—and are adapted to a wide range of soils. Thus, soybeans became yet another alternative to forests, even on those low-lying lands most prone to late-season backwater flooding. Soybean acreage in the LMAV increased fourteenfold from 1937 to 1977, with an estimated 7 million additional acres of forest cleared.

Time to Bring Back the Forest

Most (over 95 percent) of the remaining 5 million acres of LMAV bottomland hardwood forests occur in Louisiana, Mississippi, and Arkansas. The largest contiguous block of bottomland forests, which accounts for 31 percent of the total in the region, is in the Atchafalaya Basin of southern Louisiana. A considerable portion of the remainder lies between the mainline levees that parallel the banks of the Mississippi River between Cairo, IL, and the Gulf of Mexico. Since the 1990s, public and private sector groups have shown an increasing willingness to reverse the deforestation trend and attempt to restore bottomland hardwood forests of the Lower Mississippi Valley.

Early restoration efforts focused on establishing plantings of large-seeded species such as the oaks, assuming that natural processes (wind, water, and animals) would disperse enough light-seeded species to reconstruct the native forests. This low-intensity restoration relied on research conducted mostly at the **USDA Forest Service, Southern Hardwoods Laboratory** in Stoneville, MS.

Forest Service researchers at the lab in the 1960s and 1970s and their cooperators at universities, the Army Corps of Engineers, and the U.S. Department of the Interior, Fish and Wildlife Service studied ways to collect, store, and handle seed of native species; produce nursery-grown seedlings that were vigorous and would survive when planted on harvested forestland and former agricultural land; and improve the genetic composition of fast-growing hardwoods such as eastern cottonwood and sycamore.

The scientists who laid this foundation—including Bob Johnson, Harvey Kennedy, Bryce Schlaegel, Roger Krinard, Frank Bonner, and Tom Cooper—have retired, but their research (along with that of Walt Broadfoot and Jim Baker on recognizing the adaptations of different tree species to specific soil conditions and tolerance to seasonal flooding) was critical to successful plantings. Even though this work was motivated by the need to establish commercial hardwood plantations for fiber and solid wood products, the experience gained and technology developed were critical to the

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The Lower Mississippi Alluvial Valley

The Lower Mississippi Alluvial Valley (LMAV) starts at the confluence of the Ohio and Mississippi Rivers at Cairo, IL, and runs some 954 miles to the Gulf of Mexico. After the Great Flood of 1927, Congress passed the Flood Control Act of 1928, which resulted in the massive alteration of this section of the river through levees, floodways, and channel improvements. These alterations, along with steady conversion of most of the area's bottomland forests to agricultural fields, not only changed the water regime but dramatically altered wildlife habitat and biological diversity in the region.

The LMAV includes flood plains in parts of Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee. The area once supported 25 million acres of bottomland hardwood forests. Most of the region's remaining forest—highly fragmented by agricultural fields, towns, and roads—are in Mississippi, Louisiana, and Arkansas. The effects of deforestation can be seen in loss of habitat, flooding—and in the degradations to water quality that ultimately contribute, along with the farm-rich Upper Mississipppi Alluvial Valley, to the growing dead zone in the Gulf of Mexico.

Restoration efforts in the area depend on the participation of private landowners in a range of Federal and State programs that offer tree seedlings, technical support, and financial incentives. Actually improving hydrologic and habitat functions depends on how well the science of afforestation—defined as returning agricultural fields to forest stands—and stream restoration can be applied on the land.

In the early 1920s, bottomland forests were logged for timber and fuel for railroad engines—and to clear the best drained sites for agriculture. *(photo photo courtesy of Memphis Room, Memphis/Shelby County Public Library and Information Center)*

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emerging efforts to restore hardwoods for wildlife habitat and water-quality protection.

Despite proven techniques that had worked well in the small hardwood stands planted on public land by experienced personnel, the early days of the federally funded restoration programs produced disappointing results. In 1992, for example, fully 90 percent of the plantings on private land under the Wetlands Reserve Program in Mississippi failed due to the low survival of planted seedlings.

A NEW DAY FOR RESTORATION SCIENCE

Since 1990, a new generation of SRS researchers in a reorganized **SRS Center for Bottomland Hardwoods Research** in Stoneville, MS, has responded to the need for continued research on restoration methods for bottomland hardwoods, refining operational planting methods. Their continued research to identify the best way to grow good quality seedlings, prepare sites, and control competing vegetation has overcome many obstacles to successful restoration.

In the late 1990s, researchers at the center partnered with forest industry land managers to pioneer more intensive restoration methods. Modeling their approach on ecological processes and focusing on restoring functioning wetland forests as quickly as possible, they developed a cottonwood-red oak interplanting technique where a fast-growing but short-lived native species (cottonwood) is planted with a slower growing, long-lived species (Nuttall oak).

Because cottonwood cannot tolerate shading, herbicides and mechanical methods are used to control competing weeds for 1 or 2 years, or until the cottonwoods are 12 to 15 feet tall—taller than even the most vigorous weed species. Since the methods used to control weeds would also kill any other tree seedlings planted at the same time as the cottonwoods, planting the Nuttall oak seedlings between every other row of cottonwoods is delayed until after the cottonwoods are 2 years old.

This method produces forested conditions within 3 years (that's how fast the cottonwood grows!), and has been shown to produce valuable wildlife habitat and other restored ecological functions in that time. Although not all functions and native understory species are fully restored in such a short interval, observations in commercial cottonwood plantations document that these young stands are used almost as much by forest-dwelling songbirds as natural bottomland hardwood stands.

Restoring the bottomland hardwood forests of the Lower Mississippi Valley has come a long way in the last two decades, but the region is far from fully restored. Many public and private interests are now focused on restoring the area, all with their own motivations and agendas. Scientists at the Stoneville unit strive to produce restoration science that people can use, which means understanding the motivations and needs of users and focusing on the relevant questions.

Most of the land available for restoration in the LMAV is privately owned, making landowners decisionmakers, not just stakeholders. Most landowners want some financial return from their land, thus, the Lower Mississippi Valley will never be returned to its prehistoric condition (even if we knew exactly what that was). It will continue to be a working landscape, a patchwork of field and forest. Nevertheless, public lands will play a limited but very important role in the restoration of the region; public land managers ask somewhat different questions of researchers, many of these related to "ecosystem services" and "sustainability."

For restoration to be sustainable, the future restored landscape must provide a range of goods and services including timber, hunting, bioenergy, and ecosystem services such as storing carbon, moderating water flows, maintaining or improving water quality, and increasing biodiversity.

THE SHAPE OF THINGS TO COME

The Lower Mississippi Alluvial Valley certainly has had a dynamic past, and gazing into the crystal ball of the future suggests more of the same—change and adaptation. One big challenge for today's natural resources community of interest (landowners and land managers, policymakers, regulators, and researchers) is anticipating and adapting to the future climate of the area.

Climate, as we've seen in the history of the bottomland hardwood forests, drives the composition and productivity of forests by regulating available water and nutrients as well as the flooding regime. For the forests of the LMAV, there will be several direct and indirect effects of projected climate change that will have a bearing on restoration strategies and policies. Climate variability means more extremes in the weather; forests close to the coast will likely experience more severe and more frequent disturbance from hurricanes. A warming climate could cause rising sea levels that could flood coastal forests and raise the base level of the Mississippi River and its tributaries, leading to increased flooding longer into the growing season, causing a shift toward more flood-tolerant species such as baldcypress and water tupelo in expanding flood-plain forests.

These direct effects could be overshadowed by the indirect effect of a less certain climate on agriculture. If a generally drier or even a more drought-prone climate occurs, bottomland forests may see a renewed wave of clearing for cropland, especially for irrigated crops, because these flat, moist bottoms would be less risky to farm than the drier uplands.

One role of researchers is to look "over the horizon" and visualize possible futures and anticipate the needs of decisionmakers. Even if our predictions of the future are wrong, we will best serve decisionmakers 50 years from now if today's research continues to look at fundamental relationships among water, land, and people. The need for integrated, multidisciplinary, forward-looking research on the bottomland hardwood forests of the Lower Mississippi Valley is now greater than ever.

John Stanturf is project leader of the SRS Disturbance Ecology unit.

The 1940s and 50s brought another wave of forest clearing to the region, this time in the lower lying lands that could support soybeans. *(photo courtesy USDA Forest Service)*

FORESTS AND FLOODS

by Zoë Hoyle

Around 1883, my great-grandfather, Elmo Golightly Harris, went to work as a level man for the railroad in South Carolina. He stayed in touch with a fellow classmate, William Echols, a mathematician who was to offer him many opportunities, including one to work in Mississippi. He came away with a message: forests are essential to controlling floods.

"Then came a message from Echols asking me to join him in railroad construction in the swamps of Mississippi. I went, and at Memphis I learned that, due to the floods just then receding, the only way to reach my destination was by boat. So I took a river boat from Memphis to Helena. From Helena, a boatman in a skiff took me by diverse ways over the receding flood, and landed me at the edge of a cotton field. Pointing across, the man said, 'Over there you will find the railroad, and on that you can walk to Clarksdale.' I walked, and my spirits were buoyant to the last step. It was my first trip into the great swamp. Everything was novel to me.

After about 12 months, the roadbed was complete. I was assigned to run a 'trail line' eastward from Clarksdale to get out to the hills to the east. After a day or two, a messenger came with orders for us to break camp and rush for the river to escape another general flood. Levees were breaking and waters rushing eastward. The waters met us, and we hired boats. The remainder of the journey was over cotton fields and along sloughs. We reached Helena late at night, a weary and low spirited crew. Thus ended my experience in the Mississippi over-flow regions. I went in as one flood was receding and came out as another was going in. The experience gave me a radically unfavorable opinion on the Mississippi overflow regions and later experience has not modified that opinion. Many years later I wrote a paper under the title, 'Forest and Flood, A New Angle.' In this I advocate using these lands for forest only."

From: Harris, Elmo Golightly. 1939. Brief Autobiography of Elmo Golightly Harris Written in February 1939. *Ann Arbor, MI: Edwards Brothers, Inc. 41 p.*

(photo by Elise LeQuire)

Restoring the Lower Mississippi Alluvial Valley: An Interview with Elizabeth Estill

by Elise LeQuire

Elizabeth Estill is on assignment from the Forest Service national headquarters to coordinate multistakeholder restoration activities in the Lower Mississippi Alluvial Valley (LMAV). With 30 years experience in natural resource conservation—most recently as Deputy Chief of Programs, Legislation, and Communications—she brings to the task a passion for collaborative ventures.

The idea of a large, collaborative watershed restoration pilot project in the LMAV was conceived to complement the fall 2005 White House Conference on Cooperative Conservation. In April 2006, the Forest Service initiated and hosted a regional stakeholder workshop in Memphis, TN, with 41 Federal, State, and tribal agencies, private businesses, and nongovernmental organizations, to create a cooperative approach to restoration of the LMAV. From her office in the SRS Forest Inventory and Analysis unit in Knoxville, TN, Estill shares her vision of the scope of this ambitious project.

What are the challenges for restoration of the LMAV?

The LMAV is a unique ecosystem of international significance, one of the most ecologically degraded areas in North America. Currently, various agencies are focused on its restoration for specific outcomes, but the underlying science and individual restoration projects are not integrated at a larger scale. To multiply our effectiveness, we need to stitch together a quilt of high priority areas and then integrate available resources across all the different stakeholders. In other words, we need to have a common vision, and work collectively to implement it.

What are the major threats to the LMAV project area?

The region is very depressed economically, with the highest poverty rate in the Nation. It once contained over 25 million acres of hardwood forests. Now it contains fewer than 5 million acres of forests scattered across six States. Large-scale land conversion and Federal levee construction have been taking place there since the industrialization that followed the Civil War. In the 1880s, more than 100,000 acres of bottomland hardwoods were logged each year and converted to agriculture. Again in the 1960s, when soybean prices skyrocketed, forests and pastures were converted to soybeans. But these lands were marginal for row crops, so they have not been particularly good investments for farmers and have been disastrous to the environment. Soil runoff and nutrient loading, habitat destruction, and reduced flood storage capacity are just some of the consequences.

How can reforestation be made to work in the future?

Through the efforts of many organizations and local, State, and Federal programs, forested acreage is beginning to make a comeback. But it could happen faster and smarter and with more ecosystem benefits. It's not just a matter of numbers of acres; the right acres need to be restored with the right species and patterns—and that takes a joint vision.

We would like to create some green connections through agroforestry or riparian buffers between those scattered forested parcels. A key objective of this cooperative conservation project is to create ecosystem services like clean water, flood control, biodiversity, and carbon sequestration in a connected way at the landscape scale, not just one landowner at a time.

How could ecosystems services be made to work?

A major challenge is figuring out how to make conservation and restoration profitable for the private landowner. That is the key to restoration of the LMAV, and we think that markets for ecosystem services could be part of the answer.

Right now we don't know how to value many of the ecosystem services or how they might be bundled to make payments more profitable than current land management. Most ecosystem services to date don't have markets or market value; the science needs to be done to validate value. Then the key challenge will be to find markets and bundle ecosystem services and payments, creating one-stop shopping for the landowner that includes flood control, wetland mitigation banking, clean water, critical wildlife habitat, and even perhaps biodiversity credits.

WHAT IS THE ROLE OF THE FOREST SERVICE IN THE PROJECT?

Our research organization provides unparalleled science and know-how. Especially pertinent to restoring the LMAV are the **Center for Bottomland Hardwoods Research** and the **National Agroforestry Center**, both part of the Southern Research Station. Through our State and Private Forestry organization, we deliver information and funding to State and Extension agencies. We also have good working relationships with sister USDA Agencies that provide landowners with the actual money to help implement management practices, and with other Federal Agencies and conservation groups. Where we are really going to add value is in coordinating people and science, bringing them together not just on individual projects, but by identifying the opportunities and fostering the notion of cooperative conservation on a very large scale.

WHAT INCENTIVES ARE THERE FOR PRIVATE LANDOWNERS TO CONSIDER REFORESTATION?

There are financial tools as well as expert help available. Financial incentives range from USDA Farm Bill conservation and U.S. Army Corps of Engineers programs, which pay landowners for conservation practices, to private foundation funds for restoration planning. Expert help is also available locally, through county foresters and Extension agents, and nationally, such as assistance from the National Agroforestry Center. The stakeholder meeting we held in April helped us recognize the need to act jointly to make it more profitable for a landowner to go into restoration and to better coordinate our science and assistance programs. One of the next steps will be to have a research synthesis conference. A major component will be economics—how to place a value on ecosystems services and how to make them work for the private landowner or individual farmer.

Elise LeQuire is a freelance science writer based in Maryville, TN.

GOING, GOING, GONE: BUYING AND SELLING ECOSYSTEM SERVICES

by Elise LeQuire

What is the cost of losing habitat that once sustained the ivory-billed woodpecker? It's not easy to place a dollar value on iconic wildlife. Yet trading systems that set a market value on the greenhouse gas carbon dioxide are already in place, and carbon sequestration credits are openly traded on international markets. Simply put, landowners are paid to plant or maintain forests or other crops that store carbon in their leaves, branches, trunks, and roots.

Whether imposed by regulation, as in the case of the countries that signed onto the Kyoto Protocol, or assumed on a voluntary basis, credits for carbon sinks are traded around the world. In countries where carbon emissions are regulated, the system works like the cap-and-trade system of the U.S. Environmental Protection Agency's Acid Rain Program, which allows trading emissions of sulfur dioxide.

In the United States, which has no regulatory cap on carbon emissions, individuals can enter into transactions on a voluntary basis, through the Chicago Climate Exchange, for example, the first trading company in the world to deal in the international carbon sequestration market.

Though in its infancy, the concept of ecosystem services is already being adopted voluntarily by certain public agencies. A metropolitan government, for example, may purchase or lease land to protect the watershed that provides drinking water to its citizens, offsetting the cost of treating water from degraded headwaters and providing a net economic benefit to the municipality.

Ecosystem goods, including forest products such as timber, have a quantifiable market value. More sophisticated economic analysis is needed to set a value on an array of ecosystems services, such as biodiversity, wetland protection, aesthetics, and flood control.

FOR MORE INFORMATION,

visit the Web site of the Ecosystem Marketplace (ecosystemmarketplace.com), a participant in the Lower Mississippi Alluvial Valley regional stakeholder workshop held this spring in Memphis, TN.

FEDERAL PROGRAMS SUPPORTING AFFORESTATION

Forest Land Enhancement Program (FLEP)

Administered by the USDA Forest Service through State forestry agencies, FLEP provides incentives for tree planting, forest stand improvement, riparian forest buffers, windbreaks, and agroforestry practices. FLEP is available to all nonindustrial private forest landowners. For more information about how FLEP operates in your State, please contact your State Forester, through the National Association of State Foresters Web site: http://www.stateforesters.org.

Conservation Reserve Program (CRP)

Administered by the USDA Farm Service Agency with technical assistance provided by the USDA Natural Resources Conservation Service (NRCS), CRP provides cost share to establish perennial vegetation of grasses, shrubs, or trees on cropland producing an agricultural commodity, or certain marginal pastureland. After the vegetation is established, the landowner receives annual rental payments for the life of the contract (10 to 15 years).

Wetland Reserve Program (WRP)

WRP is an easement program administered by the NRCS. Under the program, high-risk agricultural lands, such as prior converted wetlands, are restored to achieve the greatest wetland functions and optimum wildlife habitat. Landowners receive technical and financial assistance to implement the practices identified in the restoration plan. Unlike CRP, landowners receive a lump-sum payment for easements. Landowners retain the right to control access and lease the land for recreational activities.

Environmental Quality Incentives Program (EQUIP)

Administered by the NRCS, EQUIP offers technical and financial assistance to address locally identified natural resource concerns. Limited resource producers and beginning farmers may be eligible to receive up to 90 percent cost-share assistance. For more information, visit http://www.lrftool.sc.egov.usda.gov.

Wildlife Habitat Incentive Program (WHIP)

WHIP provides technical and financial assistance to create high-quality habitats that support wildlife populations of national, tribal, State, or local significance. The program is administered by the NRCS through 5- to 10-year agreements. Unlike most programs, nonagricultural landowners are eligible to participate.

To learn more about the Farm Bill programs in your State, as well as additional State and local programs, contact your local USDA Service Center through the USDA Service Center locator at http://offices.sc.egov.usda.gov.

A large portion of the Lower Mississippi Valley has been converted to agricultural uses. *(photo by NASA)*

PRIVATE LANDOWNERS HOLD THE KEY

by Perdita Spriggs

The Lower Mississippi Alluvial Valley (LMAV) was once home to abundant bottomland hardwood forests. Today, little more than 5 million acres of bottomland hardwoods remain in patches ranging in size from a few acres to tens of thousands of acres.

Fortunately, times are changing, and with the help of afforestation programs, bottomland hardwood forest acreage is gradually increasing. Area landowners are a mix of white landowners whose holdings typically exceed 700 acres, and African-American owners whose holdings are often less than 200 acres. Ninety percent of the land in the LMAV is privately owned, and 70 percent of that is owned by people who do not live on their land. Regardless of who owns the land or where they live, these private landowners can now benefit from converting marginal cropland into new forest stands.

With this growing interest in afforestation, Federal and State agencies and conservation organizations are partnering to help ensure changing landowner needs are met. How effectively these agencies interact determines landowners' perceptions of and active interest in programs that promote afforestation.

Two Federal programs in particular, the Conservation Reserve Program (CRP) and the Wetlands Reserve Program (WRP), are providing landowners with incentives to convert cropland to forest vegetation. Both voluntary programs address water quality, soil erosion, enhanced wildlife habitat, and other related natural resource concerns.

CLEARING PROGRAM HURDLES FOR MINORITY LANDOWNERS

Many landowners in the Lower Mississippi Valley perceive afforestation as a good way to profit from and restore marginal agricultural lands; however, entry into Federal programs can be challenging. According to the multiagency report *Restoring the Delta*, only one in every five landowners who sign up for WRP in Mississippi is accepted in the program, with similar numbers for Louisiana and Arkansas. Additionally, many are uncomfortable signing an easement with the Federal Government. This is especially true for African-Americans.

"Many of our African-American landowners are older, and because of past experiences, including land loss, they have a hard time trusting the government," says Sandra Ford, minority outreach forester for the Mississippi Forestry Commission who works with private, nonindustrial landowners. "There are also a lot of programs, and many people just don't understand the land obligations or the jargon that is used." She notes that since 1998, African-Americans have taken a huge interest in CRP advantages. "They perceive afforestation as a good idea, but the programs are often cost prohibitive." African-Americans often do not have the initial funding needed for site preparation.

Mississippi Natural Resource Conservation Service (NRCS) Area Conservationist James Johnson adds that many minority landowners do not meet certain eligibility requirements. "Typically, we have less than 10 percent African-American participation in CRP." Not being able to demonstrate a cropping history is one barrier that many African-Americans face. Absentee landowners—who often rent land for additional income or leave hard to manage lands idle—or those who have not planted in several years find themselves unable to participate. Actual participation depends solely on whether payments per acre are comparable to the opportunity cost of removing cropland from production. But CRP benefits are worth making several attempts to secure.

"We've been trying to enroll land for the last 3 years and were just accepted this year," says Michigan resident Wilson Tate, who owns 24 acres in the Mississippi Delta, but had only 13 acres accepted into CRP. Tate's son Lorin, who lives in Washington, DC, helps manage his family's land in Mississippi and discovered CRP in a Farm Services Administration magazine. After weighing the benefits of various conservation programs, Tate decided on CRP because, "Small farmers can hardly make a living, and it's very difficult to rent land and

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For private landowners, deciding whether to keep their land in crops or plant trees is driven by economics. *(photo by USDA Natural Resources Conservation Service)*

FOREST LANDOWNERS

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get enough to just pay the taxes." His grandfather divided 500 acres among the family, and Tate hopes to encourage other family members to participate. "I would definitely consider leasing the land for hunting and fishing, and I believe future generations could benefit from putting the land in trees."

Determining whether to keep the land in crops or trees is primarily driven by economics. According to Delta Wildlife Executive Director Trey Cooke, "Landowners base their decisions on the highest and best use. If afforestation is the best use per acre of land, then that's what they will do. If they can make more money growing cotton, rice, or beans, then that's what they will do."

Delta Wildlife is a nonprofit organization that contracts with NRCS to plant trees, primarily on WRP land in Mississippi. Their collaboration with the **SRS Center for Bottomland Hardwoods Research** on seedling issues, including quality and survival rates, enables Delta Wildlife to provide a better product to the landowner—and ultimately a better stand of timber.

John Phillips, a partner in Phillips Planting Company on the edge of the Mississippi Delta, believes that afforestation is "the best use of marginal agricultural land. We cleared land in the '50s, '60s, and '70s that never should have been cleared, and those lands just are not profitable to farm in today's conditions." Phillips, who has nearly 1,700 acres in a series of CRP contracts, plans to enroll more acreage at the end of the year. However, he emphasizes the importance of economically viable incentives associated with planting trees. "Not many landowners are in a position to wait 35 years for revenue," he says, referring to the time needed for many timber stands to mature enough for profit. "Annual rental rates provide a cash flow that enables you to meet your obligations while you wait."

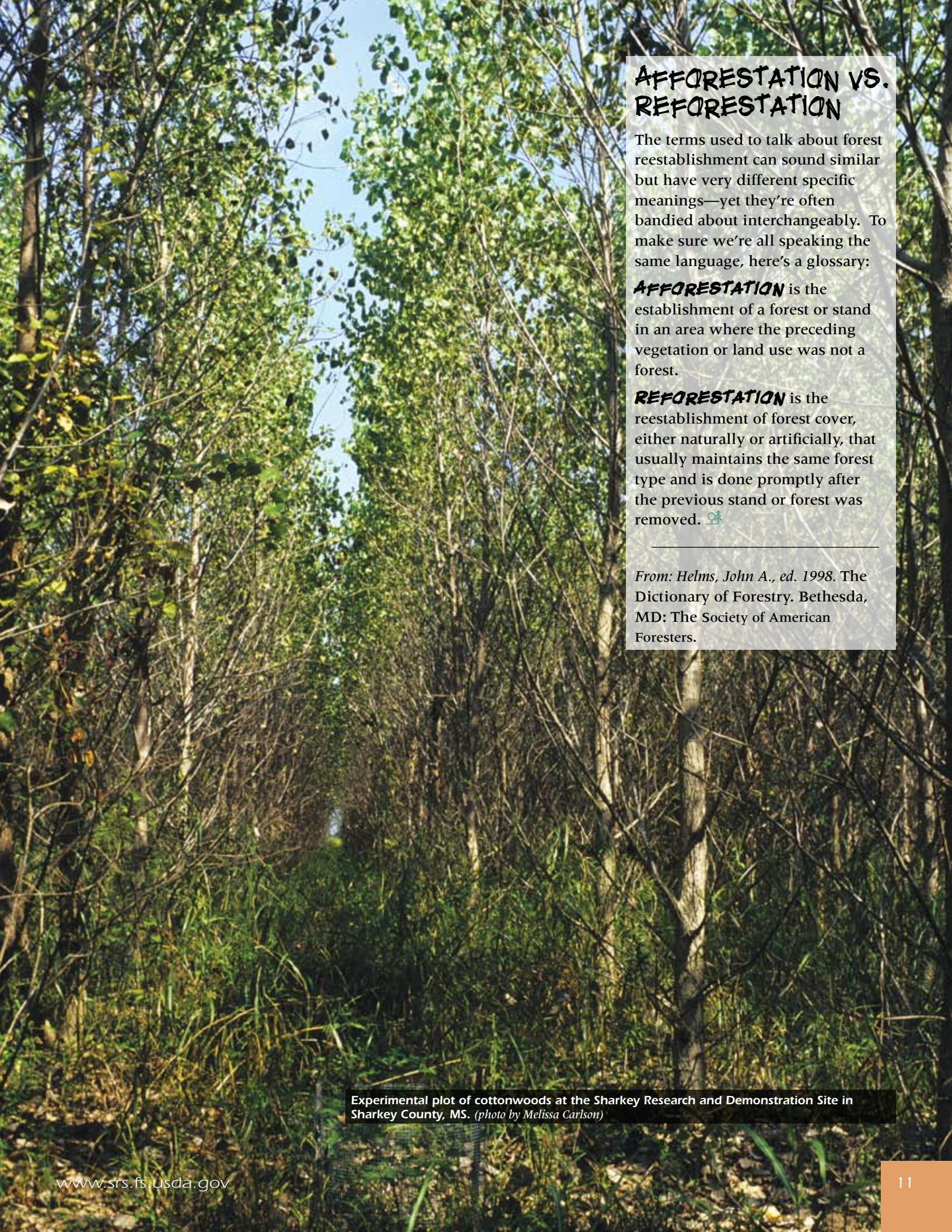
Whether managing large or small tracts, landowners must weigh the benefits and challenges of afforestation before deciding the best option. The financial benefits of planting trees on former agricultural land are realized over the long term, though water quality and wildlife benefits may be seen sooner. The cost of conversion, which includes site preparation and tree planting, begins at about $100 per acre and is normally the biggest hurdle. Average rental rates in the LMAV are around $60 per acre.

SPREADING THE WORD

Communication and education play important roles in encouraging landowners to participate in conservation programs. Agencies must work diligently to provide information materials, workshops, and demonstrations that respond to different landowner needs. White landowners normally feel comfortable visiting government offices for information, while African-Americans rely more on churches, community organizations, and word-of-mouth.

"Historically black universities play a huge role in conveying information to African-Americans," says Sandra Ford with the Mississippi Forestry Commission. "Demonstrations and tours are also extremely important, because African-Americans want to see what's working for others in their community." Mississippi Valley State University, an historically black college, will host a hardwood demonstration for the upcoming planting season as a joint effort with the Mississippi Forestry Commission and the Center for Bottomland Hardwoods Research.

Overall, landowners seem receptive to afforestation, which hopefully will continue to move forward. Studies indicate that the potential for afforestation in the LMAV is estimated at 500,000 acres or more. "It is highly likely that a large majority of the least productive cropland will be converted to forests in the next 20 to 30 years, followed by some percentage of moderately productive lands," says Trey Cooke with Delta Wildlife.



AFFORESTATION VS. REFORESTATION

The terms used to talk about forest reestablishment can sound similar but have very different specific meanings—yet they're often bandied about interchangeably. To make sure we're all speaking the same language, here's a glossary:

AFFORESTATION is the establishment of a forest or stand in an area where the preceding vegetation or land use was not a forest.

REFORESTATION is the reestablishment of forest cover, either naturally or artificially, that usually maintains the same forest type and is done promptly after the previous stand or forest was removed.

From: Helms, John A., ed. 1998. The Dictionary of Forestry. Bethesda, MD: The Society of American Foresters.

Experimental plot of cottonwoods at the Sharkey Research and Demonstration Site in Sharkey County, MS. *(photo by Melissa Carlson)*

RESEARCH MAKES AFFORESTATION WORK

by Kim MacQueen

Let's say you have inherited a few hundred acres of farmland in the Lower Mississippi Alluvial Valley (LMAV), the vast, 25-million-acre complex of forested wetlands running from Illinois to the Gulf of Mexico. You're standing outside taking it all in, fertile farmland rented out for soybean production, dotted with isolated stands of elm, ash, sugarberry, and oak.

Back in the early 1900s, that land looked a lot different. Rather than a few trees here and there, your acreage was filled with bottomland hardwoods so thick the canopy darkened the understory. The trees provided habitat for wildlife and kept the surrounding air and water clean. Over the next 100 years, it was drained and deforested for agricultural use, damaging the ecosystem and contributing to erosion, decreased water quality, and greenhouse gasses.

The land's previous use as soybean fields has driven away the wildlife that depend on large forest expanses, as well as the birds that formerly passed through here every autumn on their way south. With more and more of their habitat lost to deforestation, these mostly neotropical bird species have been squeezed into ever smaller migration corridors. In fact, fully 80 percent of the bottomland forest that used to stand in the area surrounding the Mississippi River Basin has been given over to agriculture, so vast numbers of certain species who used to live here are gone.

Remember, too, that agricultural profits are down, so keeping your land in

Double-wall plastic tree shelters have been shown to reduce animal predation, stimulate growth, and increase seedling survival of young oaks. *(photo by Melissa Carlson)*

soybeans might not make much sense. Since it's located in the flood plain, not much beyond soybeans will grow there anyway. It's a good idea to remove your land from agricultural use altogether—but unless it derives some economic benefit, you may not be able to keep your land at all.

It's enough to make you want to turn around and go back inside. Before you do, though, remember—good help is available. This is what the researchers at the **SRS Southern Hardwoods Laboratory** in Stoneville, MS, do every day.

Help Where You Need It

Stoneville scientists focus on the regeneration of bottomland hardwood forest in the LMAV, helping landowners sort out the details of returning farm land to forest—a process called afforestation.

Research forester **Emile Gardiner** has worked primarily on this issue since 1994. His work centers on providing up-to-date research aimed at helping private landowners make the best decisions for individual pieces of land.

"I work on the biological end of afforestation, researching problems like the best way to establish a forest stand on a site that has been in agricultural use for several decades," Gardiner says. "This might include identifying morphological or physiological traits of seedlings that improve survival and growth on adverse sites, gaining an understanding of environmental factors that hinder stand establishment, or promoting alternative afforestation practices that address multiple landowner objectives."

But afforestation is really an ecological imperative. The area's now profound lack of forest contributes to erosion. Agricultural runoff containing nitrogen and phosphorous flows into the Gulf of Mexico, contributing to the lack of dissolved oxygen that leads to marine dead zones.

"To encourage and sustain additional forestry land use in the LMAV, we will have to strengthen the prominence of forestry in the regional economy," notes Gardiner. Farming will also continue to be important. This means the area will never be returned entirely to the bottomland hardwoods that characterized the Big Woods of former times, but will continue to be a mixture of farm and forest.

A major aid to Stoneville's afforestation efforts comes in the form of two innovative resources from the USDA Natural Resources Conservation Service (NRCS): the Conservation Reserve Program and the Wetlands Reserve Program. Both were established by Congress to provide landowner incentives to remove economically marginal or otherwise sensitive land from agricultural use.

"Landowners can enroll in the program that suits their desires. If the program

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More Incentives to Plant Trees

USDA programs such as Farm Service Agency's Conservation Reserve Program (CRP) offer incentives to Lower Mississippi Alluvial Valley landowners to plant trees on land that may be marginally productive under agriculture. **SRS Center for Bottomland Hardwoods Research** (CBHR) scientists are providing research that supports landowners by identifying ways that they can increase their income by planting trees.

CRP establishes various practices farmers can adopt to restore bottomland hardwood forests and wetlands, improve water quality, increase wildlife habitat, and enhance carbon sequestration by establishing perennial vegetation on eligible cropland. Environmentally desirable cropland devoted to bottomland hardwood conservation practices can be enrolled at any time.

In January 2005, USDA policymakers asked Center scientists to assist in updating Conservation Practice 31 (CP-31) to provide additional economic incentives for landowners. CBHR researchers immediately saw an obvious application for the forest restoration technique they had been developing since 1995. The method involves planting slower growing hardwoods, such as red oaks, between rows of fast-growing eastern cottonwoods. This method results in a multi-species forest that can provide

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More Incentives to Plant Trees

(continued from page 13)

landowners with income from timber sales and hunting leases, and potentially from bioenergy fuels and carbon credits, making the conversion of agricultural land to forests more profitable.

After the revised CP-31 was released in May 2005, enrollments in a special CRP set-aside program associated with the update of the conservation practice doubled in the following 6 months. Currently over 26,500 acres are in CP-31. On November 11, 2005, the update to CP-31 was permanently incorporated into the CRP policies and procedures manual as CRP-496.

Estimating Carbon Capacity

Carbon trading is a relatively new development, a market approach intended to help reduce the atmospheric carbon dioxide tied to global warming. One way of trading carbon is by giving credits to projects—such as establishing forests—that offset emissions by sequestering carbon. A utility company, for instance, could offset its carbon dioxide emissions by purchasing credits from landowners who plant trees on their own land.

CBHR researchers developed a carbon sequestration case study for bottomland hardwoods which included the additional ecosystem services that result from afforesting marginal agricultural land, such as creating wildlife habitat and reducing sediments and chemicals in streams. The study used the cottonwood and red oak system developed by the Center to estimate the amount of carbon that could be fixed over a century. The case study will be revised, for later release, in accordance with the recently released USDA carbon accounting rules and guidelines, which provide information on how to estimate carbon credits in various forest types and ecosystems across the United States.

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Research Makes Afforestation Work

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involves afforestation, they are assisted by a forester who develops a management prescription for establishing trees on their property," Gardiner explains. "The landowner may receive cost-share payments for afforestation practices including site preparation, seedling planting, weed control, etc. Our research focuses on developing practices that increase the success of forest establishment."

Under these programs, owners can receive rental payments as an incentive for returning previously farmed land to forest and wetlands. Depending on the program, the payments compare favorably with land rental rates for farming—if you can rent your land to someone growing agricultural crops for $50 an acre, you'd get a similar payment through this program.

Since they were established in 1985, the NRCS programs have enrolled more than 34 million acres across the United States, according to USDA Farm Service reports. "Both of these Federal programs are widely accepted among private landowners across the South," notes **Steve Meadows**, research forester at Stoneville. "As a result, many thousands of acres of marginal cropland in our area have been restored to bottomland hardwood forests."

What Works and Why

What's the key to regenerating forest in the LMAV? The answer is . . . it depends. On what you plant and where, on whether you use seed or seedlings, on whether and how well you care for the fledgling site once you've planted—and on your own personal objectives as a landowner.

"It's very site-specific," Gardiner says. "You have to ask the landowner to define the outcomes they wish to achieve through afforestation. Soil types, hydrologic regimes, and other variables—including the amount the landowner is willing to invest—are considered when designing an afforestation plan to meet the defined management objectives. Getting the landowner to articulate what they want of their forest 10, 20, or 100 years in the future is often very difficult."

That's where Meadows comes in. While Gardiner helps landowners through the planting stage, Meadows looks at the long term, studying intermediate stand management—the silvicultural practices prescribed after the stand has developed through the sapling stage. If you're deciding whether to plant, say, all oak or a mix of species, and you want to know what your stand will look like after it's been there for 20 years, Meadows is your man.

"It is extremely important for hardwood forest managers to understand the patterns of stand development, particularly in mixed-species forests," Meadows notes. "Knowledge of stand development patterns and processes allows hardwood silviculturists to make more effective stand prescriptions and to more accurately predict the tree- and stand-level responses to those prescriptions."

A No-Win Boxing Match Among Trees

Since the 1980s, Meadows has helped to conduct workshops for landowners through Mississippi State University, outlining the best practices for stand management. One of the first decisions, when you're looking at how and what to plant, is whether your forest will be a pure stand (all one species) or mixed, and how that stand will fare after 15 or 20 years. Because of the various developmental patterns of bottomland hardwood species, there's a lot to consider when trying to predict future stand structure.

"One of the most serious problems associated with establishing a pure oak plantation is that the individual oak trees don't compete very well with each

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Working Trees Reconnect Land with Clean Water

by Michele Schoeneberger

Applied research from the **SRS National Agroforestry Center** in Lincoln, NE, can provide landowners in the Lower Mississippi Alluvial Valley (LMAV) with options to address erosion and flooding along their own streambanks—and, by extension, slow down the spread of the dead zone in the Gulf of Mexico.

The fertile soils and ideal climate that led to the outstanding diversity of species in the LMAV also helped create its rich agricultural heritage. Unfortunately, the massive land conversion to agriculture over the last two centuries has reduced the area's natural habitat to only 10 to 20 percent of its original area. As the landscape has fragmented, the links among ecological processes have been pulled apart.

These shifts in land use have deteriorated the capacity of the land to provide critical ecosystems services such as clean water and wildlife habitat, and led to serious local problems such as polluted drinking and recreational waters, destabilized streambanks, and loss of indigenous plant and animal species. Pollution and sediment from the LMAV also contribute to the hypoxia that has caused the dead zone in the Gulf of Mexico.

Meanwhile, the profitability of agriculture has steadily declined over the past decades, threatening the livelihoods of landowners. Taken together, these problems bring into serious question the future ecological and economic health of the LMAV. Trying to address both these aspects in the mostly privately owned lands of the area will be challenging.

To preserve important wildlife functions in the area, groups such as Ducks Unlimited and The Nature Conservancy have focused on identifying and protecting the few remaining critical lowland forest patches such as the Big Woods Conservation Area in northern Louisiana. Other groups, including the Forest Service, are focusing on how to actually reestablish forests, or afforest, on agricultural lands, but nearly 80 percent of the 25 million acres in the LMAV are still in agricultural production. The average farm size is 300 acres—and most farmers are reluctant to convert their lands back to forests. More options are needed to help landowners participate in restoring ecological functions.

This is where the *Working Tree* practices, developed by the National Agroforestry Center, come in. Specifically designed to blend agricultural and forestry production, these tree-based practices provide a means to help reconnect and restore ecosystem functions across the highly fragmented LMAV landscapes while keeping the land in agricultural production.

A Win-Win Situation

Although there are many *Working Tree* practices that can address the area's primary issues of water quality and wildlife, riparian forest buffers hold the most promise. By filtering, trapping, and bioprocessing sediment, fertilizer, and pesticide runoff from adjacent lands, riparian forest buffers protect and enhance water quality, while providing highly critical roosting, nesting, foraging, and travel habitat for wildlife. These same riparian forest buffers also provide greenhouse gas mitigation by sequestering significant amounts of carbon dioxide.

Planted in long thin strips, riparian forest buffers use a relatively small proportion of the land, allowing the farmer to still derive an annual income from traditional agricultural production. Depending on the objectives of the landowner, these plantings can be designed to also provide an additional source of annual income from either specialty forest products such as flowers or mushrooms, from hunting fees, and, in the longer term, from timber products. Best suited for marginal agricultural lands, *Working Tree* practices could create a real win-win situation, helping to restore the LMAV while providing real economic benefits to landowners.

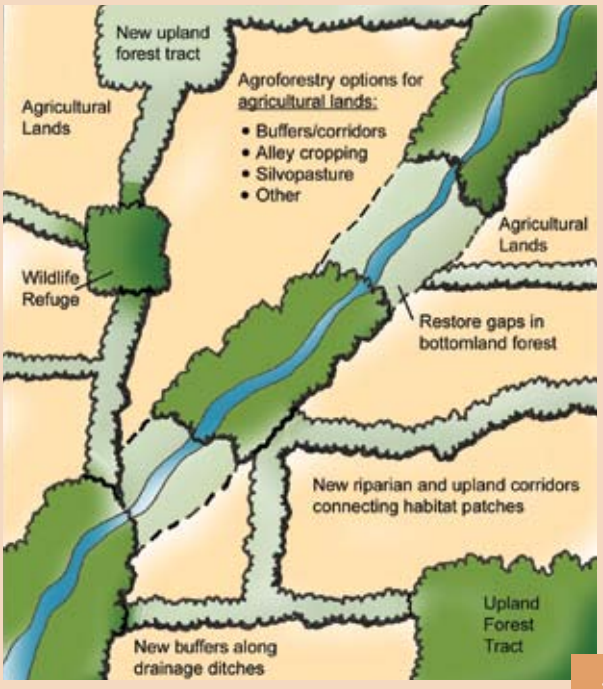
There are multiple Federal, State, or other cost-share programs to help landowners establish these plantings. Getting the biggest bang for buffer-buck from these programs, however, requires locating these practices on the landscape where they can do the most good. The National Agroforestry Center develops the information and tools needed by natural resource professionals to help landowners plan and design *Working Tree* plantings for maximum benefit.

Efforts are focused on answering three basic questions: How do these buffers work? How do you build them? Where do you place them on the landscape? Tools are being developed to analyze spatial patterns of runoff and to design variable-width riparian forest buffers that better match location-specific needs. Other tools include GIS-guided assessments that help identify high priority patch and riparian connectivity areas, where certain agroforestry products can be grown, and where to locate buffers to best address water-quality issues. While these tools can be used separately, they work best when combined to provide multiple benefits from one planting.

Successfully restoring the LMAV depends on coming up with solutions that encompass the diverse concerns of its landowners, and requires collaboration among the many entities involved and across all its lands. *Working Trees* practices can connect across land ownerships while addressing multiple ecosystem services.

For more about the full range of *Working Trees* practices, see *Working Trees for Water Quality* at http://www.unl.edu/nac/workingtrees/wtwq.pdf.

Michele Schoeneberger is Project Leader of the SRS National Agroforestry Center located in Lincoln, NE.



HYPOXIA AND THE DEAD ZONE

The dead zone in the northern Gulf of Mexico is an area along the Louisiana-Texas coast where the deepest water contains less than 2 percent parts per million of dissolved oxygen, not enough for fish and other aquatic organisms to live. Fish leave the area; bottom-dwelling organisms that cannot move experience extreme stress, often dying.

This hypoxia—defined as the absence of oxygen available to living tissues—is caused mainly by the excess of nitrogen delivered to the Gulf of Mexico by the Mississippi River as it flows through both the Upper and Lower Mississippi Alluvial Valleys. Sources of excess nitrogen and other nutrients include: runoff from developed land, soil erosion, agricultural fertilizers, and atmospheric deposition. Nitrogen promotes the growth of algae. As the algae dies, it sinks to the bottom, using up available oxygen.

Since 1993, the average extent of the dead zone in the Gulf of Mexico has been around 6,200 square miles, twice the average size measured between 1985 and 1992. The hypoxic zone reached its maximum size so far in 2002, when it was measured at around 8,500 square miles—larger than the State of Massachusetts.

RESEARCH MAKES AFFORESTATION WORK

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other," Meadows says. "By the time they are about 30 to 40 years old, individual oak trees in a pure oak plantation are like evenly matched heavyweight boxers in a championship fight. Neither boxer can gain an advantage over the other and, by the 15th round, they've both pretty much had it, but neither one goes down. Both of them are exhausted, but neither one is willing to give up. Oaks in a pure oak plantation behave much the same way. They've all experienced the effects of severe competition for a number of years, but generally are not able to out compete their neighbors. As a result, the plantation usually stagnates quickly and the majority of the trees suffer reduced growth and vitality."

Does that mean mixed-species stands are inherently healthier? Again, that depends. Most of the existing research is on mixed-species natural stands, and it remains to be seen whether individual trees in pure stands would likely play out their years together under the same boxing-match scenario. Stoneville scientists are researching stand management of both pure and mixed-species stands now, in small locations ranging from Alabama to Texas.

Stoneville scientists have also set up studies at the Sharkey Restoration Research and Demonstration Site, a 3,000-acre holding of the U.S. Fish and Wildlife Service in Sharkey County, MS. Once a managed farm, the land has been offered up as a study site to researchers interested in forest restoration and afforestation.

One 240-acre afforestation study on the Sharkey site is carved into 20-acre plots, with different treatments assigned to each plot. This lets researchers monitor variables such as wildlife use and changes to soil chemistry. So if you're interested in knowing the difference between the ongoing development of a pure stand of oak and that of a mixed stand of several species, you can visit and take notes about what each one looks like. Each year, hundreds of people—from landowners to student groups to Federal policymakers—visit the Sharkey site.

So—the challenge is a big one. Landowners in the Lower Mississippi Alluvial Valley who want to return their land to forest have a lot to do, but a wealth of assistance and information is right at hand.

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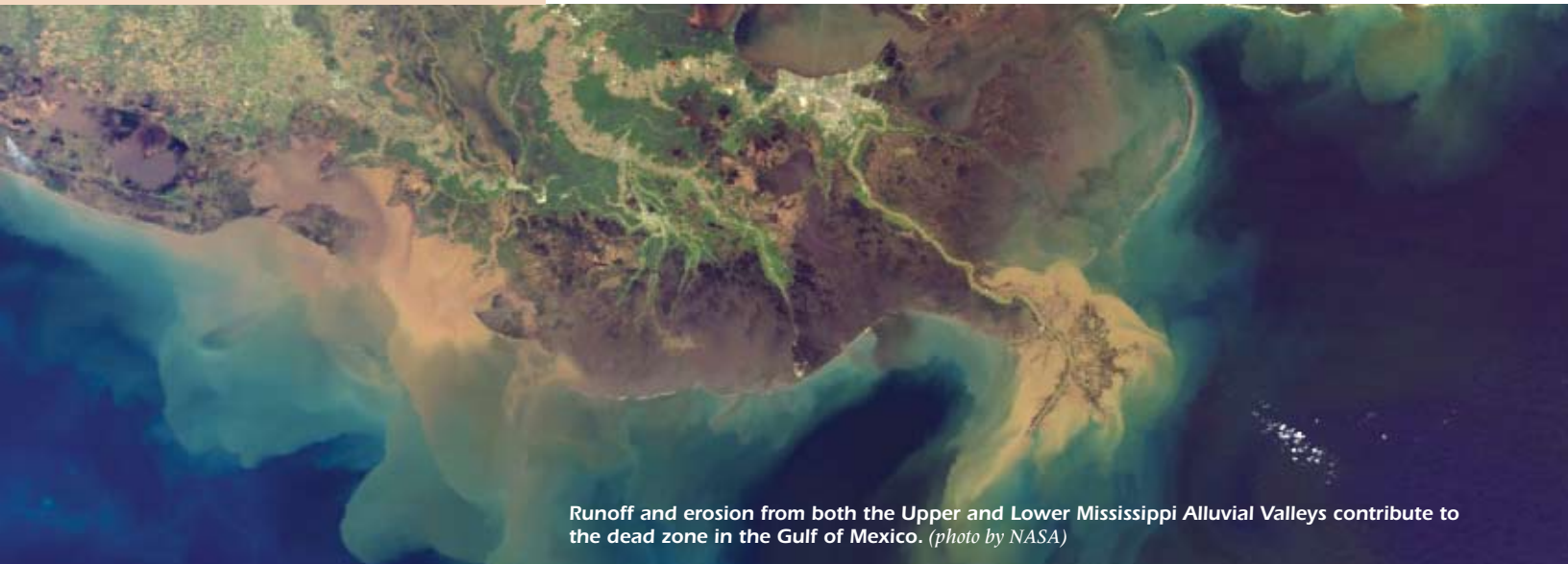

Runoff and erosion from both the Upper and Lower Mississippi Alluvial Valleys contribute to the dead zone in the Gulf of Mexico. *(photo by NASA)*

THE PROMISE OF COTTONWOOD

by Zoë Hoyle

A multinational collaborative effort sequenced the first tree genome earlier this year. Researchers chose to work on poplar (specifically black cottonwood or *Populus trichocarpa*), a tree which is widely used for pulpwood and papermaking—as well as for forest and riverbank restoration. Researchers at the **SRS Southern Institute of Forest Genetics (SIFG)** in Saucier, MS, are using information from the genome project to develop new tools to improve eastern cottonwood (*Populus deltoides*), a member of the poplar family native to the Lower Mississippi Alluvial Valley.

As a native, eastern cottonwood is well adapted to the region, and has long been a favorite among tree breeders and forest geneticists working to improve fiber and wood characteristics. Named for the cottony appearance of its seeds, the tree is relatively easy to propagate from cuttings and grows quickly, making it an ideal choice for restoring riverbanks and flood plains, as well as a renewable source of biomass for energy—and eventually, carbon credits.

In the 1960s, researchers at the SRS unit in Stoneville produced a number of valuable cottonwood clones that were used to establish forest plantations or tree farms. Later federally funded research and work by the forest industry enhanced this early effort, providing many of the high-quality clones now used in afforestation efforts across the South. Recently SIFG scientist **Tom Kubisiak** participated in a research group that mapped an important disease resistance gene in cottonwood. "Diseases are a limiting factor in cottonwood production," says **Dana Nelson**, project leader for SIFG. "Using genetic markers to map the resistance gene is an important step in reducing this limitation."

SIFG scientists usually work on pine genetics, mapping traits to improve growth and resistance to disease, but are now also working on the poplar genome itself, mapping each DNA sequence to its 19 chromosomes. "Poplar was chosen in part because its genome is relatively compact, around 40 times smaller than that for pines," says Nelson. "Sequencing the genome has resulted in an explosion of basic information about the poplar family. It's becoming the research model for all deciduous forest trees, and our cytogenetics research lead by **Nurul Faridi** is playing an important role."

"In addition to enhancing the afforestation efforts in the Lower Mississippi Valley, eastern cottonwood holds a lot of promise as a renewable source of quality biomass for conversion into bioenergy and biofuels," adds Nelson. "The genetic materials developed to date—combined with available data on how well they perform on various sites and the new genetic information and tools that we are helping to develop—should lead to a valuable tree crop for river bottomlands throughout the Southern United States."

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Eastern cottonwood is ideal for restoring riverbanks and has great potential as a renewable source for biomass energy. *(photo by USDA Forest Service)*

SRS Center for Bottomland Hardwoods Research project leader Ted Leininger.
(photo by Nathan Schiff)

SNAPSHOT
FROM THE FIELD

TED LEININGER IN THE LOWER MISSISSIPPI ALLUVIAL VALLEY

by Claire Payne

The Mississippi Delta practically exudes a sense of place—the people, the climate, the soil, and the water all contribute to a unique complexity.

When project leader **Ted Leininger** moved from Riverside, CA, to Stoneville, MS, in December 1991 to join the **SRS Center for Bottomland Hardwoods Research**, it wasn't the first time he'd lived in the South. Leininger lived in Durham, NC, while an undergraduate at Duke University, and in Blacksburg, VA, while earning his Ph.D. at Virginia Tech. But after moving to Mississippi, he found an earlier link between the North Carolina Piedmont and the Mississippi Delta.

As the Nation grew in the early 1800s, people migrated from the Carolinas and east Tennessee to the Delta. "Old Delta families can trace their heritage from the Carolinas and Tennessee," he says. "It was a natural expansion that also brought clearing to the vast thicket called the Big Woods. The restoration of that hardwood thicket is something I am keenly interested in."

The land continues to dominate life today. "Landowners in the Delta are very savvy." Leininger says. "If they can generate income by taking their land out of agricultural production for forest restoration, and it makes sense, they will see it as an opportunity. They are very concerned about the environment and appreciate the natural habitat and wildlife. They're hunters and fishermen. They realize the value of conservation practices."

"Government will need to provide the research to develop programs for incentives," Leininger says. A proven example is the intercropping technique developed by SRS scientists over a 10-year period that involves interplanting red oaks or other bottomland tree species beneath an established eastern cottonwood plantation. This stand-establishment practice results in the development of a two-storied forest that can provide landowners with several income sources. When the practice was added to the Conservation Reserve Program's options in May 2005, the regimen sparked a 200-percent increase in enrollment over a 6-month period.

Leininger refers to the Delta Council as an example of entrepreneurial leadership that will drive economic stability in the region. Started in 1935 by a group of citizens to promote trade and economic development, the Delta Council recently expanded its focus to include literacy and health problems. Endemic poverty

still characterizes the Lower Mississippi Alluvial Valley, and the issues of obesity, diabetes, and heart disease are in critical need of attention.

Leininger believes the success of the **SRS Center for Bottomland Hardwoods Research** goes back to its continuing history since the 1930s. (It was shut down during World War II, but reopened after the war.) In the 1950s, people leading the lab established the Southern Hardwood Forestry Group. A few years ago this group celebrated its 50-year anniversary. Three charter members, now in their mid-70s to early 80s, attended. "This is a field-oriented group of practitioners who get together in the woods and talk about reforestation, harvesting, and other issues," says Leininger. Two hundred members of the field group met in Vicksburg, MS, in April 2006.

"It's great to see this dynamic outdoor classroom," says Leininger. "People are wearing field clothes and boots, kicking the dirt, and talking. Practitioners are talking to researchers. Someone invites you to put in a study. A lot of cooperative and collaborative efforts have their inception there. Lifelong friendships are formed. There's someone who just graduated from forestry school, who has a lot of book knowledge but no practical experience, talking to someone who's walked in the woods for 50 years."

The center also hosts an annual Southern Hardwood Forest Research Group meeting, which was started 2 years after the field group meeting. The research group typically draws 80 to 100 attendees from Mississippi and neighboring States of Arkansas, Louisiana, Tennessee, and Alabama, and often from Texas, Kentucky, and Georgia.

The Center for Bottomland Hardwoods Research includes the **Southern Hardwoods Laboratory** in Stoneville and the **Ecology of Aquatic and Terrestrial Fauna Team** in Oxford, MS, led by **Mel Warren**—as well as **Cal Meier** in Pineville, LA, and **Jack Vozzo**, retired scientist and volunteer in Starkville, MS. "The scientists in this unit love what they're doing," says Leininger. "Through their research, they connect to stakeholders. There's an additive energy through their care for the land, natural resources, and environmental issues. I encourage and support their science and garner resources to make sure they have what they need."

The Mississippi Delta feels like home to Ted Leininger. He's a native of southeastern Pennsylvania, where his ancestors were farmers. He finds southerners warm, engaging, and very hospitable. "They are willing to open up and bring you in," he says. "In the South, the focus is still largely agricultural, especially in the Delta. This real connection to the land brings about hospitality and warmth. Drivers pass each other, whether on a two-lane or a highway, and the hand comes off the steering wheel. They're saying hello."

One of Leininger's favorite books is *Rising Tide: The Great Mississippi Flood of 1927 and How It Changed America*, by John M. Barry. "Reading *Rising Tide*, I learned about the region, my job, flood control, and its importance to the people of this area," he says. "The book covers so many things—natural history, science, and engineering; hydrology and the hydraulics of the Mississippi River; local, regional, and national policies; race relations—all wrapped around one event: the 1927 flood. It was probably the first time in the Nation's history it was recognized that a national response was needed to get a region back on its feet," Leininger adds. "The lessons learned are true today. All societal levels are affected by a natural disaster. It's the great equilizer. When I drove down Highway 90 in Gulfport, MS, after Katrina, it was very humbling. Half-million-dollar and million-dollar homes were gone. On the concrete slabs where these homes once sat were 30-foot FEMA trailers."

WHERE HAVE ALL THE BIRDS GONE?

by Zoë Hoyle

You might say **Paul Hamel** is drawn to working with difficult birds. First, it was the cerulean warbler, now the ivory-billed woodpecker—one a tiny piece of blue sky, the other so large and spectacular that it's been called the "lord god" bird. Or maybe he's trying to help understand what has made both large and small birds disappear from the forests of the Lower Mississippi Alluvial Valley (LMAV)—and what sort of forest management practices could help bring them back.

Hamel, research wildlife biologist with the **SRS Center for Bottomland Hardwoods Research**, has a long history of studying the impact of landscape change and forest management on neotropical migratory birds, which typically breed in North America and migrate south in the winter. Changes to both the breeding areas and winter habitats of these birds have impacted their numbers over the last half century. Hamel's research on one neotropical migrant, the cerulean warbler, has taken him to the lower slopes of the Andes in South America, as well as into the forests of the LMAV.

The cerulean warbler gets its name from the male's color—bright sky-blue above and white below, with a black collar and narrow black streaks along his flanks. The female is dull turquoise above with a pale blue crown, and yellowish white below. The cerulean warbler, once very common in the forests of the Eastern United States, has steadily vanished from sight, its numbers declining by 70 percent since the mid-1960s. When present, the small (4-inch) bird mostly stays in the upper canopy of mature deciduous forests. The bird spends most of the year in Western South America, but its breeding range used to cover much of the Eastern United States and Southern Canada.

"The Lower Mississippi Valley, which is in the traditional breeding range of the cerulean warbler, is an area where the bird is much less abundant than before," says Hamel. "We really don't know why specifically. There is a lot less forest, and it is arranged differently, which presents many more problems for the bird."

A STEADY, PUZZLING DECLINE

In the heyday of the cerulean warbler, the forests of the LMAV were connected and compact—meaning there was a lot of interior forest in relation to the perimeter. Today, the forests that remain tend to be in low areas, often along rivers. The fragments may seem large—sometimes 300,000 acres—but if you look closely at a map you can see that they run in long strips that are as little as 5 miles wide. Again, there's no real way to know exactly what aspect of forest fragmentation has led to the steady (3 percent per year) decline in cerulean warbler populations and a shift in the bird's range towards the Northeast, away from the Lower Mississippi Valley. "We can't really tell you what kind of forest structure is ideal or why the warblers choose to nest where they do," says Hamel. "The way we approach it is to look at where we find cerulean warblers and then make inferences about why that habitat attracts them."

In 1992, Hamel and Bob Cooper (then at the University of Memphis and now at the University of Georgia), led by Winston Smith (formerly with SRS and now with the **USDA Forest Service Pacific Northwest Station**), started a long-term study of neotropical migratory birds on three sites in the LMAV known to harbor cerulean warblers. The sites, all located in the flood plain of the Mississippi River, are under three different ownerships: one on private timber company land in Arkansas; the second on State park land in Shelby County, TN; and the third on the Chickasaw National Wildlife Refuge in Lauderdale County, TN. "We've gone back every year to monitor the territories of not only cerulean warblers, but also American redstarts, northern parulas, yellow-throated warblers, and other neotropical migrants," says Hamel. "This gives us a snapshot of what is happening with birds that depend on forest habitat to breed."

The timber company site located in Desha County, AR, is the only site where experiments have been done on managing forests specifically for the cerulean warbler. "We have learned

from observations that male ceruleans prefer tall trees with spreading crowns as song trees, while females tend to favor positions lower in the canopy," says Hamel. Researchers worked with the owners of the site, the Anderson-Tully Company, to reserve a 135-acre plot from any forest management for 10 years. At the end of that time, the plot, which lies within a surrounding area of 320 acres, was divided in half. The timber company applied their normal partial-cutting prescription to one half. This involved cutting in the overstory to reduce mortality, improve species composition and spacing, and increase growth of the residual stand. It also involved removing many stems from the midstory to encourage the regeneration of desirable species. On the other half, they left a larger proportion of the midstory trees, with the intent of providing habitat for cerulean warblers. "So far, we have cerulean warblers using the side treated for them, and not using the other side," says Hamel. "Anderson-Tully Company, now a part of the Forest Land Group TIMO, continues to be a highly valued cooperator in the cerulean warbler work."

Other research findings confirm habitat loss as the main reason for the decline of cerulean warbler populations in North America. Studies also confirm a growth in populations where forests are regenerating. "We have some evidence that we can regenerate and manage forests to create or improve habitat for the cerulean warbler," says Hamel. "But we need to act quickly—and throughout the bird's range—to address its decline."

The cerulean warbler depends on the upper canopy of mature deciduous forests to breed. *(photo © Mike S. Nichols)*

WHY DID THE "LORD GOD" BIRD DISAPPEAR?

Since the April 2005 report of sightings of the ivory-billed woodpecker, believed extinct for 50 years, teams of volunteers have been combing the Big Woods of the Cache River and lower White River in Arkansas, hoping for another glimpse of the bird known as "Elvis" or the "lord god" bird, this last from the exclamations of those seeing the large, dramatic bird for the first time.

Unlike most of the LMAV, the Big Woods of Arkansas still contain areas of old-growth forest, including cypress trees estimated at 800 and 1,000 years old. The area surrounding the Big Woods is actually a patchwork of bottomland forest and agricultural fields—many in rice. The reported sighting of the ivory-billed woodpecker has spurred efforts to increase the size of protected lands and to afforest portions of the area.

In 2005, an Ivory-Billed Woodpecker Recovery Team was formed to prepare a comprehensive recovery plan for the species. **Pete Roussopoulos**, SRS Director, was named to the executive committee, and Hamel was named to the biology working group. The bird was known to have inhabited large areas of bottomland forest with patches of dead and dying trees that harbored the insects it prefers. The exact reason for its disappearance from a range that once spanned the South is still unknown.

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"Tasked with writing the biology part of the recovery plan, we started reviewing the records of the bird in this region, reading James Tanner's 1942 monograph of studies done on the Singer Tract in Louisiana," says Hamel. (Renowned for his studies of the ivory-billed woodpecker, Tanner was one of the last to see the bird before the recent sightings.) "It was Tanner's opinion that the viability of the ivory-billed woodpecker was limited by the supply of the insects it feeds on. We decided to do a food provision study to explore this idea."

Tanner based his idea on the insects he found in nests, by examining trees ivory-bills had foraged on, and by analyzing the stomach contents of ivory-billed woodpeckers in collections. Along with a number of specific insect foods still available in the area, Tanner identified three primary forage trees: sweetgum, sugarberry (a type of hackberry), and Nuttall oak. All are still common in the Mississippi Alluvial Valley; Nuttall oak is a very popular species for afforestation efforts.

BUILDING A MYSTERY

Tanner described ivory-billed woodpeckers as scaling the bark off trees to locate the wood-boring beetle larvae they preferred. When Hamel brought in SRS entomologist **Nathan Schiff** to work on the study, a mystery developed. "When I showed Nathan the list of insects Tanner had identified from stomach and nest leavings, he pointed out that all these insects burrow deep into the tree. There's no way the bird would find them by stripping off the bark."

This apparent contradiction led Hamel and Schiff to start a study to quantify the volume of insect food available to the ivory-billed woodpecker in relation to tree species and conditions. This spring they chose four sites, two in the Big Woods of Arkansas and two across the river in Mississippi. Choosing individual trees from Tanner's three preferred species, Hamel and Schiff subjected them to four levels of insult, from no wounding up to girdling to kill. At the end of this growing season, when insects have had plenty of time to lay their eggs, the researchers will go back and harvest half of the research trees, then place them in isolation chambers to measure insects as they emerge.

"We'll be looking at how many insects emerge in relation to the level of wounding," says Hamel. "I don't think anyone's done this type of ecological assessment of the insects attracted to dead and dying trees. We hope it will give us some answers about food availability for ivory-billed woodpeckers, but it will also yield information about insect predation that forest managers can use to increase the yield of their stands."

More trees on the land may lead to more warblers and neotropical migrants nesting high in the canopy—and maybe to more sightings of the "lord god" bird.

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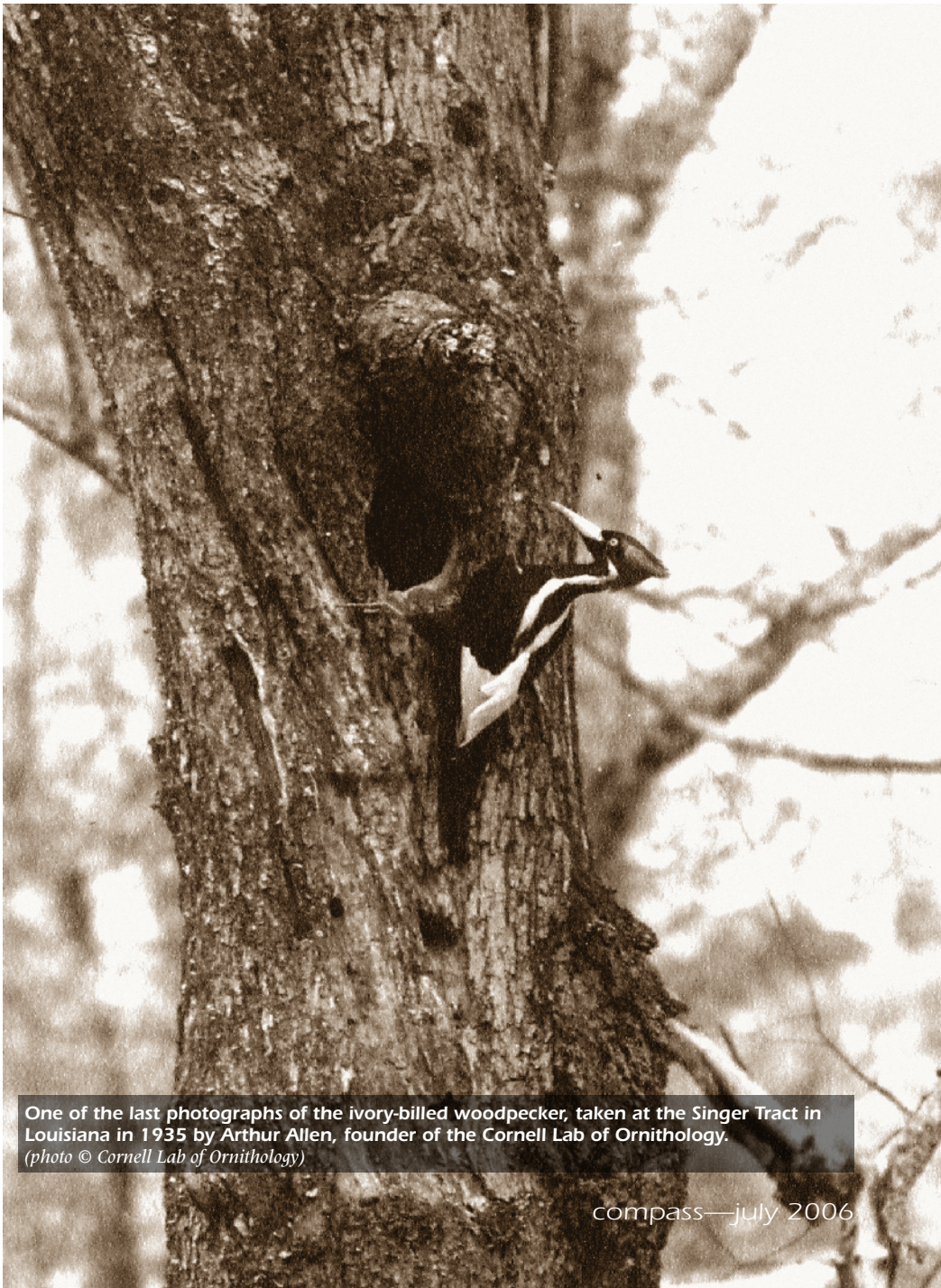

One of the last photographs of the ivory-billed woodpecker, taken at the Singer Tract in Louisiana in 1935 by Arthur Allen, founder of the Cornell Lab of Ornithology. *(photo © Cornell Lab of Ornithology)*

PONDBERRY: MODEST BUT MYSTERIOUS

by Zoë Hoyle

A team of researchers from the **SRS Center for Bottomland Hardwoods Research** are working with the U.S Army Corps of Engineers (Army Corps) and the U.S. Fish and Wildlife Service (USFWS) to learn as much as they can about the biology and ecology of pondberry, an endangered plant with significant remaining populations in the Lower Mississippi Alluvial Valley (LMAV).

Pondberry is a rarely seen woody plant that grows in seasonally flooded forests and on the edges of sinks and ponds. Growing up to 6 feet tall, pondberry plants consist of many stems that are connected underground. The small yellow flowers bloom in the very early spring before the plant itself—and most other plants—leaf out. The red berries appear in the fall in clusters where secondary stems meet the main stems. A member of the Lauraceae family, pondberry most closely resembles spicebush. About 36 populations of the plant remain in sites across seven Southern States, with the majority in the LMAV. The plant has recently been discovered in Alabama.

Pondberry was listed as endangered in 1986. A large part of its habitat disappeared when forests were cut for timber or for conversion to agricultural fields, and as wetlands were drained or flooded. "Pondberry has always been a rare plant," says **Margaret Devall**, SRS research ecologist who leads her unit's efforts to understand the plant's reproductive biology and was the first in the unit to work on it in 1997. "We still know very little about the ecology, physiology, even genetics of pondberry—and, more importantly, we don't know what is required to sustain the populations we still have."

WHEN PUSH COMES TO SHOVE

Pondberry studies got underway bigtime when flood measures proposed for the southern part of the Delta region of Mississippi raised questions about the survival of the plant in the **Delta National Forest**. USFWS biologists were concerned about the persistence of pondberry populations. Though populations of the plant are scattered across seven States, one of the largest populations is on the Delta National Forest. Over 5 years, some $5 million has been devoted to collaborative studies on the biological and ecological factors that may affect the survival of pondberry. This is likely the largest single study funded for an endangered plant in the Southeast.

As collaborators in the study, SRS researchers set up permanent plots in the Delta National Forest and others on nearby sites to monitor environmental factors. They are also investigating the role of flooding and light availability on pondberry at a large-scale impoundment facility, and have set up greenhouse studies to look at competition, seed germination, and storage, as well as seed

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Pondberry is a rarely seen woody plant that grows in seasonally flooded wetlands and on the edges of sinks and ponds in six Southern States. *(photo by Nathan Schiff)*

PONDBERRY...

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persistence in a seed bank. Together, they take an integrated approach to pondberry, looking at ecology, insect predators, fungal pathogens, physiological responses to light availability and flooding, population genetics, seed physiology, and seed dispersal.

THE MYSTERY OF DISPERSAL

Pondberry has two modes of reproduction. The plant seems to reproduce mostly by shooting up new stems—called stolons—from the rootstock. These clonal stems (meaning they all have exactly the same genetic material) flower at around 2 to 3 years of age, and live for only a few years. The plant bears seed-containing fruit, but it is rare to find a seedling near existing populations. This brings up two questions: How are new populations of pondberry established? If by seed, how are the seeds dispersed?

Existing populations of pondberry are so far apart that some researchers speculate that the seeds were once spread by floods. Because so little was known about how pondberry seeds were carried to new locations, SRS researchers submitted a proposal to the Army Corps to try to catch seed dispersers on tape. They set up five video cameras with infrared illuminators to record a pondberry population in the Delta National Forest from late fall until all the fruits had disappeared in late December. Various birds and other creatures appeared on the tape—but whether animals such as the Louisiana black bear are primary dispersers is still unknown.

To look at dispersal by birds, **Paul Hamel**, **Carl Smith**, and fellow SRS researchers selected fruiting pondberry colonies on the Delta National Forest and set up a series of 1-hour observation periods to record the species of birds seen near the pondberry colony, perched on a pondberry plant, or actually eating a pondberry fruit. They observed 82 different species of birds in the colony area, and 12 species perched on the plant. Of these, the hermit thrush and northern cardinal were observed actually eating pondberry fruit. Hermit thrushes swallow the entire fruit, so are unlikely to drop seeds in the immediate area. This makes them a good candidate for local dispersal of seeds, but the birds move relatively small distances in the winter and are not likely to carry seeds across the open space between forest patches.

Dispersal, or its lack, could severely limit future populations of pondberry, since many of the existing populations are in small wooded areas surrounded by agricultural fields that limit further clonal colonization. "In the past the seeds could also have been dispersed by floodwaters, but flooding is controlled in these areas," says Devall. "Without human intervention, it is unlikely that new pondberry colonies will appear to replace those lost to habitat alteration or destruction."

With a small grant from the National Wildlife Federation, center scientists Devall and **Nathan Schiff** have investigated introducing pondberry to new sites. Colonies on protected sites have done well, but private landowners are reluctant to plant endangered species on their land. Reintroduction is also not a solution for the USFWS, which is more interested in how to protect the naturally occurring populations of pondberry.

In addition to those mentioned in the article, SRS researchers involved in the pondberry project are: **Kristina Connor**, **Craig Echt**, **Emile Gardiner**, **Tracy Hawkins**, **Ted Leininger**, **Brian Lockhart**, and **Dan Wilson**.

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Louisiana black bear at the Tensas River National Wildlife Refuge. *(photo by John and Karen Hollingsworth courtesy U.S. Fish & Wildlife Service)*

WHAT DOES A BEAR DO IN THE WOODS?

SRS researchers are looking at the Louisiana black bear, a threatened species in the Lower Mississippi Alluvial Valley (LMAV), as a possible disperser of pondberry seeds.

Knowing if pondberry can be dispersed across widely distributed patches of bottomland hardwood forest that characterize the LMAV is key to determining whether the plant will continue to survive in the Mississippi Delta. "The seeds are relatively heavy," says **Paul Hamel**, research wildlife biologist with the **SRS Center for Bottomland Hardwoods Research** (CBHR) who works on the dispersal aspect of the pondberry project. "We've ruled out wind because you would need a gale force with these seeds, and water will only disperse seeds a short distance."

From their video surveillance studies in the **Delta National Forest**, SRS researchers found one definite disperser in the hermit thrush—a 6-inch, brownish forest bird that forages on the forest floor, and with its distinctive call, is more often heard than seen. "We found a good match between hermit thrush movements and populations of pondberry within that particular forest, but the hermit thrush does not usually fly from one forest patch to another," says Hamel. "So we began to look at animals that range more widely."

The red wolf and the Louisiana black bear, omnivores to varying degrees, seemed likely candidates. In 2003, Hamel arranged with the Jackson, MS, zoo to feed pondberry fruit to captive red wolves and Louisiana black bears. Hamel ruled out the red wolves, which are almost entirely carnivorous, after several failed attempts to get them to eat pondberry fruit. "To even get them to ingest the fruit I had to wrap them in meat patties," he says. "Even then, the dominant female would carefully pick the meat off and leave the fruit."

Hamel found that the Louisiana black bear would eat pondberry fruit readily—now comes the fun part of doing seed dispersal research. "If you're going to evaluate an animal as a seed disperser, you have to see how well the seed germinates after it's been eaten and defecated," says Hamel.

First, you count how many seeds go in the bear and how many come out to measure the likelihood of the seeds getting through the bear's digestive system. "Kind of like trying to retrieve an earring your kid has swallowed," Hamel comments. Then you take the seeds and plant them in greenhouse pots to determine germination rates. "Over a third of the seeds we planted did germinate," says Hamel. "So we have proof that the fruits will go through the bear and germinate."

The next step is to track the movements of Louisiana black bears in the wild to see how far they actually go—and whether their movement patterns could, at least partly, provide an opportunity for wider dispersal of pondberry plants. CBHR researchers are continuing their video surveillance studies of pondberry patches for possible dispersal agents, and have entered into a partnership to track individual Louisiana black bears using global positioning satellite (GPS) radio collars. The U.S Army Corps of Engineers provided CBHR with funds to purchase the collars, which were provided to biologists with the Mississippi Department of Wildlife, Fisheries and Parks (MDWFP), who attach them to Louisiana black bears they are monitoring in the Delta National Forest and the Yazoo National Wildlife Refuge.

Once common in Mississippi, loss of habitat reduced the population of Louisiana black bear—one of 16 recognized subspecies of the American black bear—to less than 12 individuals by 1932. MDWFP biologists are using the radio collars to learn more about their home range sizes and movements in hopes of increasing populations. The U.S. Fish and Wildlife Service and the Delta National Forest are involved in helping with the capture of the bears, as are interested local landowners.

Hamel and the other pondberry researchers also want to know where bears go. "We know where the pondberry populations are, and we will be able to tell from the radio collar monitoring whether the bears have had the opportunity to visit and eat berries," he says. "Then we can start to chart how far the bears move in the time it takes the seeds to move through their bodies. We're just in the beginning, looking at patterns, but it's an interesting possibility—and another reminder of how animals and plants are connected."

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CATFISH, CRAYFISH, AND MUSSELS

by Zoë Hoyle and Jim Cleveland

It's May in Oxford, Mississippi, still cool, not muggy yet. It's time to haul out the waders and get the electric current going.

Outside their building near the University of Mississippi campus, **SRS Ecology of Aquatic and Terrestrial Fauna Team** leader **Mel Warren** and fellow fisheries research biologists **Susan Adams** and **Wendell Haag** haul out nets, boots, and chest-high waders. Meanwhile, technicians **Gordon McWhirter** and **Amy Commens** hook an electrofishing boat—a squarish metal craft rigged up to stun fish with an electric current—behind the team's pickup truck and make sure the electricity is flowing.

The boat is just one of many tools the team uses to research warmwater fish, freshwater mussels, and crayfish in the forested wetlands of the Lower Mississippi Alluvial Valley (LMAV). Part of the **SRS Center for Bottomland Hardwoods Research** located at Stoneville, MS, the members of the Oxford team work together to understand the aquatic ecosystems of the Southeast, and have contributed to a new understanding of the diversity and imperiled status of aquatic species in the region.

The team conducts numerous studies in the LMAV, looking at the effects of deforestation, stream channelization, and other land practices. Fish, mussels, and crayfish can all be critical indicators of water quality and biodiversity, and the data the team develops on ecology, biology, and community structure and function inform efforts to restore, conserve, and afforest in and around the streams and rivers of the area.

As part of a larger, comprehensive 5-year baseline study, the team developed sampling protocols and conducted the first standardized, quantitative inventory of fish and fish habitat in the National Forests of Mississippi. The field work, which also included an inventory of freshwater mussels and the distribution and habitat associations of crayfish, was completed in 2004. Though the findings are still being analyzed, results include a geo-referenced database that covers physical and biological conditions for 364 stream reaches in over 7 ranger districts, and 110 fish species, 16 crayfish species, and numerous mussel species.

"While the national forests represent only 5 percent of Mississippi's land area, they are important habitat for 110 species of freshwater fish out of the 220 or so that we know occur in the State," says Warren. "So these are critical places to preserve these stream fish, and mussels and crayfish as well. Understanding the populations in these areas can also provide us with information we need to help restoration efforts on other ownerships."

SPACE, TIME, AND FISH

Today the team is headed east of Oxford to a put-in on the Little Tallahatchie River in the Holly Springs National Forest, where they will launch the boat for a trial run. This part of the Little Tallahatchie River is a good place to measure the effects of channelization on freshwater aquatic organisms; there's access here to a relatively unaltered section of the river, as well as to a section that was diverted and channelized for flood control. Channelization and incision—a condition where the stream has entrenched into the land along its banks—are the rule rather than the exception in the LMAV, and present a major challenge for aquatic conservation and restoration efforts.

The team previously used three small tributaries of the Little Tallahatchie for a 17-month study on how fish assemblages—the community of fish defined by the species present, their life cycles, and how they interact with one another—vary in relation to the seasons. Two of the streams are channelized with incised banks, while the third stream remains relatively unaltered. The channelized streams are wide and shallow with shifting sand bottoms, almost no canopy cover, and very little in-stream wood or other cover for fish. The unaltered stream is extensively shaded, with in-stream wood forming debris piles, riffles, and pools.

"There hasn't been much work done on how fish assemblage structure in channelized, incised, sand-bottom streams varies in relation to time and space," says Warren. "Establishing this variability in relation to range and life cycle is extremely important to conservation efforts. Monitoring

The fine-lined pocketbook mussel has developed special structures to attract the sunfish its specialized larvae, called glochidia, depend on for the intermediate stage of their development. *(photo by Wendell Haag)*

data, used to assess the influence of human actions or natural events on fish assemblages, cannot be interpreted reliably unless you know how the assemblage reacts over time prior to the event you're looking at."

The aquatic team uses a combination of techniques to sample and monitor fish, ranging from snorkeling (when the water is deep enough and clear enough to count fish) to electrofishing. Many warmwater fishes—shiners, darters, madtoms—are small and difficult to see even when the water is clear. For the fish assemblage study, the team used a stationary seine and electrofished downstream towards it so that the stunned fish were swept by the current into the seine. Because of the tight mesh of the seine, they were able to capture smaller sized and younger fish often missed with other techniques.

For this study, they captured almost 18,000 fish representing 13 families and 52 species. They found high variability in fish assemblages over time in the channelized streams, though each of the streams maintained its own unique characteristics. "High temporal variability in the more degraded streams suggests an environmental factor is coming into play, rather than lack of food or predation," says Warren. "In other studies, we found that the presence of even minor amounts of in-stream wood is associated with fish faunas indicative of more stable and predictable conditions over time."

NATURE'S WATER FILTERS

Back out on the water, research fisheries biologist Wendell Haag, now in waders, holds up a large, dark shell with a thin, sharp wing. "This mussel digs into the bottom of the stream, leaving the wing pointing up. You can guess how it got the name Alabama Heelsplitter."

Haag devotes long hours to the study of freshwater mussels, wading through streams to locate and sometimes collect species with colorful names like pimpleback, monkey face, mucket, pistolgrip, and pocketbook. Extensive surveys of mussel populations in the LMAV were not done until the 1980s, and most of those were done on the larger rivers.

The aquatic team has focused on finding out more about the freshwater mussels in the small streams around the Little Tallahatchie (though this is just one aspect of their South-wide inventories, and they have also done studies in other parts of the LMAV). From 1993 to 2001, they surveyed for freshwater mussels at 135 sites in north-central Mississippi, with a large number of the sites lying within the Holly Springs National Forest. One result of their efforts was the discovery of eight previously unknown populations of the rayed creekshell, which is considered a species of special concern by the American Fisheries Society.

With their work extending across the southeastern region, Haag and Warren are emerging as leaders in the field of freshwater mussel research. The two have been in the forefront in identifying the unique relationships with fish that mussels depend on to carry out their

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CATFISH, CRAYFISH, AND MUSSELS

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reproductive strategies, uncovering previously unknown links between 20 different mussel species and their fish hosts.

"Reproduction is one of the most highly sensitive events in an organism's life history, and reproductive traits are often useful indicators of how a species will respond to environmental changes," says Warren. "Knowledge of an organism's reproductive ecology is critical to its successful management and conservation."

Understanding this delicate dance between species, which involves mussels attracting their fish hosts with a wide range of inventive lures, is as necessary to stream function and water quality as any other aspect. It's a connection Haag makes readily.

"Freshwater mussels filter water, take the food resources they need, and deposit the rest in discrete packets called pseudofeces which other organisms then break down. Freshwater mussels in the Southeast as a whole have suffered greatly from the loss of habitat over time, and many species of both mussels and fish are now faced with extinction. We can only benefit from restoring the organisms and functions of these systems."

OF CATFISH AND CRAYFISH

Researcher Susie Adams pilots the boat upstream into the area where the old stream intersects the newer, man-made channel. She asks McWhirter to take over the wheel and steer her closer to the bank, where she leans out of the boat to examine the yellow-fringed blossoms of swamp privet—a shrubby native that grows in wetlands and along streams throughout the Lower Mississippi Alluvial Valley. Adams studies ecological relationships that link land and water; in this case, whether channel catfish act as dispersal agents for swamp privet seeds.

"Seeds of the swamp privet eaten and defecated by catfish are still capable of germination," says Adams. "Although common in the Amazon River basin, this is the first example of fish dispersing seeds in North America."

Along with research wildlife biologist **Paul Hamel**—the fourth member of the Oxford team—and other colleagues, Adams is looking at how the fruits are beneficial to catfish, how often the fruit is available to them, and whether birds such as cedar waxwings also play a part in seed dispersal for swamp privet. It may seem an odd focus, but it's part of the SRS team's growing interest in aquatic-terrestrial linkages.

"Aquatic-terrestrial linkages occur at the interface between land and aquatic ecosystems and can assume many forms," says Warren. "Research so far suggests that there are many more of these linkages than previously suspected, especially in forested wetlands and bottomland streams, and that they will have important implications for managing bottomland hardwood and riparian forests."

But Adams logs a lot more time with crayfish than catfish. She has spent a good part of the last 2 years studying the distributions of crayfish inhabiting small streams throughout the National Forests of Mississippi, and studying the ecology and life histories of several crayfish species native to north Mississippi.

"There's really very little information about crayfish in the Lower Mississippi Valley," she says. "We don't know where different species occur, their best habitat, or the ecological interactions among species."

It appears that the aquatic team's interest in crayfish may result in the description of at least one new species. "There is a surprising amount of undescribed variation in crayfish," says Adams. "Whether this will lead to descriptions of species or subspecies, or just better accounting of the variation within species remains to be seen. We are collaborating on some studies of crayfish genetics to help clarify some of this confusion."

FROM DROUGHT, A LESSON IN RESILIENCY

The aquatics team has also done extensive research on the effects on fish and crayfish of the record-breaking drought in Mississippi that ended in the fall of 2000. Because of the drought, numerous small streams or stream segments in northern Mississippi that normally flowed year-round dried up or were reduced to small, stagnant pools—presenting a good opportunity to study how fish and crayfish recolonize after water flow returns. The team sampled fish and crayfish in 7 stream reaches that dried and 5 that remained flowing throughout the drought, with the sampling starting before the drought and lasting through recovery.

"We found that the assemblages of fish and crayfish stayed pretty much the same

Members of the SRS aquatics team on a preliminary survey of the Little Tallahatchie River in northern Mississippi. From left to right: Technician Amy Commens, research fish biologist Susie Adams, and technician Gordon McWhirter. *(photo by Jim Cleveland)*

in the flowing streams," says Adams, "but, as you would expect, there was a great difference initially between pre- and post-drought in the dried-up streams."

Recolonization was slow in the winter, but picked up in the spring months. By June 2001, the fish populations in the dried streams were much the same as they were before the drought. "In previous studies, rapid recolonization was observed immediately after the disturbance," says Adams. "In this case, the rapid response came months later, partially due to the timing of the disturbance in relation to the life cycles of the fish. This illustrates how important it is to understand the temporal cycles of fish assemblages in managing for disturbance."

Far less is known about crayfish response to drought, and, before this study, there was no published work on the species common to the area. "Numerically, the patterns of recovery in crayfish were very similar to fish, except that crayfish populations increased slightly more rapidly in the winter," says Adams. "Crayfish sizes drifted toward smaller individuals, indicating that reproduction may be more important as a mechanism of recovery than immigration from other stream segments."

"A critical part of the recovery of fish communities is the ability of fish to move among the networks made up of these small tributary streams," says Warren. "Effective management must ensure the freedom to move, especially during times of stress such as drought. To really understand these processes, we need to extend our population studies over larger spatial scales and multiple seasons."

"All of our studies are designed to understand the aquatic system so that we can provide information for the scientifically based management and recovery of aquatic animals in the stream and riparian ecosystems of the Lower Mississippi Valley—and in the Southeastern United States as a whole."

It's a daunting task, but Warren's team is up to it.

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RECOMMENDED READING

Most of the technical reports and articles listed below are available in full text PDF format from the SRS publications database at http://www.srs.fs.usda.gov/pubs/, or from TreeSearch, the Forest Service-wide research publications database, at http://www.treesearch.fs.fed.us/.

CAN WE BRING BACK FAULKNER'S BIG WOODS?

Allen, J.A.; Keeland, B.D.; Stanturf, J.A. [and others]. 2001. **A guide to bottomland hardwood restoration**. Biol. Resour. Div. Inf. and Tech. Rep. USGS/BRD/ITR–2000–0011. U.S. Geological Survey. Gen. Tech. Rep. SRS–40. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 132 p.

Stanturf, J.A.; Conner, W.H.; Gardiner, E.S. [and others]. 2004. **Recognizing and overcoming difficult site conditions for afforestation of bottomland hardwoods.** Ecological Restoration. 22(3): 183-193.

Stanturf, J.A.; Madsen, P. 2005. **Restoration of temperate and boreal forests.** Boca Raton, FL: CRC Press. 569 p.

Stanturf, J.A.; Schoenholtz, S.H.; Schweitzer, C.J.; Shepard, J.P. 2001. **Indicators of restoration success: myths in bottomland hardwood forests**. Restoration Ecology. 9(2): 189-200.

PRIVATE LANDOWNERS HOLD THE KEY

Stanturf, J.A. 1999. **Restoring the Delta**. Draft business plan. [Place of publication unknown]: [Publisher unknown]. 51 p. http://www.fs.fed.us/largewatershedprojects/businessplans/lmv_draft.doc. [Date accessed: June 7, 2006].

RESEARCH MAKES AFFORESTATION WORK

Gardiner, E.S. 2006. **Early response of interplanted Nuttall oak to release from an eastern cottonwood overstory**. In: **Proceedings of the 13th biennial southern silvicultural research conference.** Gen. Tech. Rep. SRS–92. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station: 611-614.

Gardiner, E.S.; Stanturf, J.A.; Schweitzer, C.J. 2004. **An afforestation system for restoring bottomland hardwood forests: biomass accumulation of Nuttall oak seedlings interplanted beneath eastern cottonwood.** Restoration Ecology. 12 (4): 525-532.

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Lockhart, B.R.; Meadows, J.S.; Hodges, J.D. 2005. **Stand development patterns in southern bottomland hardwoods: management considerations and research needs.** In: The state of our understanding. Columbia, MO: University of Missouri: 439-448.

WORKING TREES RECONNECT LAND WITH CLEAN WATER

Bentrup, G.; Kellerman, T. 2004. **Where should buffers go? Modeling riparian habitat connectivity in northeast Kansas**. Journal of Soil & Water Conservation. 59: 209-215.

Dosskey, M.G.; Eisenhauer, D.E.; Helmers, M.J. 2005. **Establishing conservation buffers using precision information.** Journal of Soil & Water Conservation. 60: 349-354.

Schoeneberger, M.M.; Bentrup, G.; Francis, C.F. 2001. **Ecobelts: reconnecting agriculture and communities.** In: Flora, C., ed. Interactions between agroecosystems and rural human communities. Advances in Agroecology. Boca Raton, FL: CRC Press: 239-260.

TED LEININGER IN THE LOWER MISSISSIPPI ALLUVIAL VALLEY

Barry, J.M. 1997. **Rising tide: the great Mississippi flood of 1927 and how it changed America**. New York: Simon and Schuster. 528 p.

WHERE HAVE ALL THE BIRDS GONE?

Hamel, P.B. 2003. **Winter bird community differences among methods of bottomland hardwood forest restora2tion: results after seven growing seasons.** Forestry. 76(2): 189-197.

Hamel, P.B.; Dawson, D.K.; Keyser, P.D. 2004. **How can we learn more about the cerulean warbler (*Dendroica cerulea*)?** The Auk. 121(1): 7-14.

Hamel, P.B.; Meadows, J.S.; Gardiner, E.S.; Stanturf, J.A. 2001. **Chainsaws, canebrakes, and cotton fields: sober thoughts on silviculture for songbirds in bottomland forests.** In: **Bottomland hardwoods of the Mississippi Alluvial Valley: characteristics and management of natural function, structure, and composition.** Gen. Tech. Rep. SRS–42. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station: 99-105.

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Pondberry: Modest but Mysterious

Connor, K.; Schafer, G.M.; Donahoo, J. [and others]. 2006. **A study of the early fruit characteristics of pondberry.** In: **Proceedings of the 13th biennial southern silvicultural research conference.** Gen. Tech. Rep. SRS–92. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station: 564-568.

Devall, M.S.; Schiff, N.M.; Boyette, D. 2001. **Ecology and reproductive biology of the endangered pondberry, *Lindera melissifolia* (Walt) Blume.** Natural Areas Journal. 21: 250-258.

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U.S. Department of Agriculture Forest Service, Southern Research Station. 2002. **A guide to finding pondberry [Brochure].** Sci. Update SRS–003. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. [Not paged].

What *Does* a Bear Do in the Woods?

Smith, C.G., III; Hamel, P.B.; Devall, M.S.; Schiff, N.M. 2004. **Hermit thrush is the first observed dispersal agent for pondberry (*Lindera melissifolia*).** Castanea. 69(1): 1-8.

Catfish, Crayfish, and Mussels

Adams, S.B.; Warren, M.L. 2005. **Recolonization by warmwater fishes and crayfishes after severe drought in Upper Coastal Plain hill streams.** Transactions of the American Fisheries Society. 134: 1173-1192.

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Haag, W.R.; Warren, M.L. 2003. **Host fishes and infection strategies of freshwater mussels in large Mobile Basin streams, USA.** Journal of the North American Benthological Society. 22(1): 78-91.

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Taylor, C.M.; Holder, T.L.; Fiorillo, R.A.; Williams, L.R.; Thomas, R.B.; Warren, M.L. 2006. **Distribution, abundance, and diversity of stream fishes under variable environmental conditions.** Canadian Journal of Fisheries and Aquatic Sciences. 63: 45-45.

How to Plant Bottomland Hardwoods on Difficult Sites

Stanturf, J.A.; Conner, W.H.; Gardiner, E.S.; Schweitzer, C.J.; Ezell, A.W. 2004. **Recognizing and overcoming difficult site conditions for afforestation of bottomland hardwoods.** Ecological Restoration. 22(3): 183-193.

How to Plant Bottomland Hardwoods on Difficult Sites

Landowner's TOOLBOX

Although about 370,000 acres of farmland in the Lower Mississippi Alluvial Valley (LMAV) have been planted in bottomland hardwoods over the last decade, more than 90 percent of the planted sites have not performed well, failing to meet the criterion of 100 woody stems per acre. Attributing these failures to lack of information on how to analyze site conditions and overcome difficult conditions, SRS researchers provided the following guidelines based on research at the **SRS Center for Bottomland Hardwoods Research** in Stoneville, MS.

Flood conditions

The former agricultural areas you are considering for afforestation are more than likely low and wet. Tree seedlings are damaged or killed by sitting for long periods in soil saturated by standing or flowing water, and by high water levels that cover them during the growing season. These conditions need to be kept in mind when beginning afforestation efforts.

Assess your site for flooding potential

Before choosing which trees to plant, get at least a 5-year history of flooding on the site from the landowner or farm manager.

Match tree species to the site

Tree species can be planted in less frequently flooded conditions than they can tolerate, but not vice versa. For example, baldcypress, a water-tolerant species, can survive on a ridge, but cherrybark oak, which has low tolerance for flooding, should never be planted in a slough. The best strategy is to plant the species adapted to the worst flooding conditions.

Control flooding while seedlings get established

It may be possible to control flooding until seedlings get tall enough to survive by building reservoirs or constructed wetlands.

If possible, time planting to avoid floods

Bare-root seedlings should be dormant when planted, which means December to March in the LMAV. Some sites are under water during this period; avoid flooded conditions if possible. Waiting to plant after spring floods recede is desirable, but planting bare-root stock in June is risky.

If you have the money, consider using container stock

Research has shown that container stock can be successfully planted into late summer—but it is expensive. The average cost for a bare-root seedling in 2004 was $0.20 to $0.30 for a range of hardwoods, inexpensive when compared to large ontainer seedlings (5 to 6 feet tall) at $6.00 each.

If you have to plant in standing water, prune the roots

A tree seedling planted in standing water will shed its existing root system and develop another one more adapted for life in standing water. When planting in standing water, heavily root-prune the seedling and insert it into the soil without digging a hole.

Adverse soil conditions

Successfully growing bottomland hardwoods depends on the physical condition of the soil, moisture and nutrient availability, and aeration. Oaks, the most popular trees for afforestation, grow best on moist, well-drained sites with good fertility and soils of medium texture. Unfortunately, most of the soils in the LMAV are heavy clay. Soil chemistry, indicated by pH levels, can also be a problem, as can traffic pans (compacted areas formed by repeated passes of farm equipment) on former agricultural fields.

Again, select tree species matched to site conditions

Determine if the site is minimally acceptable for a tree species by testing the pH of the soil and using productivity tables available from forest extension agents.

Prepare the site adequately

Planting trees in former agricultural land requires disking at least twice with a heavy disk in late summer or early fall at a depth of 8 inches, preferably 15 inches. Deeper plowing or ripping is recommended for sites with heavy traffic pans. Site preparation for cottonwoods is more intensive, requiring double disking and ripping.

Fertilize, especially if planting cottonwoods

Agricultural soils in the LMAV have lower organic matter content and may be depleted of nitrogen. Fertilize high-nitrogen-demanding species such as cottonwood at the time of planting. Fertilization may stimulate weed growth, but the resulting early height growth may also reduce risk from flooding. Few guidelines are available for fertilizing hardwoods.

Competing vegetation

Even under the best of conditions, tree seedlings have to compete with weeds—both vegetation native to the site and nonnative invasive plants—which take advantage of disturbance to spread. Woody vines, either native or nonnative, are a particular problem. Problem plants must be taken care of before planting hardwoods, since it is virtually impossible to control after planting without harming the trees.

Prepare the site by cultivation

It has been a common practice to plant tree seedlings without any site preparation after the agricultural crop has been harvested, or to disk once on fallow sites. Disking has been shown to significantly improve the survival and growth of hardwood seedlings. Mowing is totally ineffective for reducing competing vegetation before planting.

Apply herbicides before planting

Research has shown that applying herbicides in old fields with "normal" weeds improved the survival of oaks by as much as 25 percent. In fields with woody vines and nonnative invasive plants, effective control before planting will probably determine the success or failure of the restoration effort. For specific controls, start with Jim Miller's, *Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control*, available online at http://www.invasive.org/eastern/srs/.

Afforestation techniques for areas with standing water and soft sediments include planting severely pruned bald cypress seedlings. In this practice, the lateral roots of the bald cypress seedlings are removed and the tap root is cut to 9 inches long. The seedlings are then inserted into the soil or sediment without digging a hole. *(photo by William H. Conner)*

Be careful if you use herbicides after planting

Take care to use the proper herbicide for the situation. Specific prescriptions are available in the article from which this information was excerpted. (See below.)

Animal effects

Plant-eating animals such as beavers, nutria, and white-tail deer can dramatically affect the survival and growth of bottomland hardwood seedlings. Small mammals such as rodents and rabbits are often responsible for failures of directly seeded plantings.

Put up fencing

Fencing a 10-acre site with 8-foot-high tensile deer fence with 2-foot-high poultry wire at the base to exclude rabbits was estimated to cost $1,470 or more in 2001. Flooding makes electric fencing impractical.

Use tree protection devices

Double-wall plastic tree shelters—tubes placed around young seedlings—have been shown to reduce animal predation, stimulate growth, and increase seedling survival. In large restoration areas, shelters may not be cost effective. They are relatively expensive, and are easily knocked down and swept away by floods.

Reduce vegetation cover

On most sites, controlling the herbaceous vegetation removes the cover for small mammals and reduces their effect on seedlings.

For more information:

These guidelines were excerpted from:

Stanturf, J.A.; Conner, W.H.; Gardiner, E.S.; Schweitzer, C.J.; Ezell, A.W. 2004. **Recognizing and overcoming difficult site conditions for afforestation of bottomland hardwoods.** Ecological Restoration. 22(3): 183-193. Available in full text at http://www.treesearch.fs.fed.us/pubs/7391, or the article can be ordered from SRS.

The article includes a waterlogging tolerance-rating table for common tree species of the Southern United States, and a table to help landowners establish waterlogging tolerance classes for their land based on flooding duration and season. The two can be used together to roughly determine the species to plant on a site where the flooding history is known.

Since the 1920s, the USDA Forest Service has maintained a system of experimental forests to test hypotheses and collect long-term data about the ecological effects of fire, grazing, insect infestations, air pollution, and other disturbances. In the South, researchers from Federal agencies and universities use 15 active experimental forests for studies ranging from the practices needed to maintain healthy forests, to the water filtration functions of forests, to habitat restoration for endangered species.

Experimental forests are some of the few places in the United States where long-term data are collected about forests and how they change over time. These living laboratories also serve as demonstration sites where cooperators and landowners can see the results of different forest management options.

Landowners can visit the experimental plots set up at the Sharkey Research and Demonstration Site to look at how different plantings perform over time. *(photo by Melissa Carlson)*

WHAT CAN EXPERIMENTAL FORESTS TEACH US ABOUT AFFORESTATION?

A TALE TOLD BY TWO FORESTS

Scientists predict that the South's forest acreage will remain stable over the next several decades, with losses from urbanization in the Atlantic States offset by tree planting on abandoned agricultural lands further west. Restoration of bottomland hardwoods on Lower Mississippi Alluvial Valley lands will play a large role in guaranteeing the success of these predictions. Bottomland hardwood restoration is not just planting trees, but rather a process that involves selection of species, thinning, and protecting against diseases and insect infestations.

Two experimental sites, the **Delta Experimental Forest** and the **Sharkey Research and Demonstration Site**, have provided scientists with ideal conditions for studying bottomland hardwoods and developing tools and guidelines for restoration by landowners.

THE DELTA EXPERIMENTAL FOREST

The Delta Experimental Forest is a State-owned 2,600-acre property in Washington County, MS, that was established for research in a 1945 agreement with SRS. Drained by a network of ditches, it was a working forest whose timber receipts paid for a crew of laborers and technicians to establish and maintain research studies.

Research during the first 30 years or so involved thinning, developing methods for growing quality southern hardwoods, evaluating results of efforts to improve eastern cottonwood clones, and studying the progression of heartrot diseases and the life cycles and impacts of insect borers. Later studies included determining the causes of oak decline and investigating red oak-sweetgum stand dynamics.

These studies provided much of what we know about species-site relationships on the poorly drained, less fertile soils deposited by the Mississippi River. In addition, several eastern cottonwood clones—selected during the 1960s and 1970s by geneticists at the **SRS Southern Hardwoods Laboratory** and still used throughout the South by forest industry, government agencies, and some foreign countries—were tested in the Delta Experimental Forest.

The 1970s saw a change in allocation of harvesting revenues to other State priorities, resulting in a decline in both forest operations and new studies. By the mid-1990s, heartrot had degraded many older trees. Several ice storms struck the forest in the 1990s; the worst in February 1994 severely damaged the crowns of

(continued on page 36)

EXPERIMENTAL FORESTS

(continued from page 35)

most canopy trees. Many of the stands were cut in the late 1990s to regenerate degraded forest stands. Oak seedlings were planted to supplement natural oak regeneration.

Current research concentrates on wildlife, with scientists beginning a new study to look at insect food for the ivory-billed woodpecker. The study involves the establishment of some 200 cages to hold bolts of wood cut from trees infested with wood-boring insects. As insects emerge from the wood, they will be identified, quantified, and further studied.

THE SHARKEY RESEARCH AND DEMONSTRATION SITE

Late in the 20th century, new legislation enacted to stimulate the conversion of agricultural land to forestry and a desire to develop more ecologically oriented restoration alternatives prompted scientists to seek a site for new management studies. Fortunately in 1995, the Yazoo National Wildlife Refuge established a bottomland restoration site on abandoned farmland in nearby Sharkey County. Like the Delta Experimental Forest, the Sharkey Site consists of poorly drained, clayey soils typical of slack water areas along the Mississippi River. And like the abandoned agricultural land throughout the area, the Sharkey soils tend to form deep cracks that close when wet. For these reasons, research findings from the Sharkey Site can be applied almost anywhere in the lower Mississippi Valley.

Collaborators at the Sharkey Site include scientists and managers from Federal Agencies—U.S. Fish and Wildlife Service, the USDA Forest Service and Natural Resources Conservation Service, the U.S. Geological Survey, and the Army Corps of Engineers—State agencies, universities including Mississippi State and Mississippi Valley State, nongovernmental organizations including the National Council for Air and Stream Improvement, and private industry including Crown Vantage Corporation and International Paper Company.

The most prominent of the new restoration studies contrasts several options for interplanting cottonwoods with red oaks: inexpensive nonintensive practices, conventional practices familiar to managers, and intensive practices that address multiple ecological objectives. Another study of natural regeneration focuses on patterns of invasion by trees and shrubs. And in a large fenced area, new techniques are being developed to establish black willow on harsh wetland sites; because of its rapid growth, this species could be useful in addressing climate change by removing and storing carbon.

One unique component of the infrastructure at the Sharkey Site is an impoundment of compartments that can be independently flooded and drained for studies on pondberry, an endangered forest shrub, and other woody plants.

In publications, tours, new technologies, industry demonstrations, and training for students, scientists at the Sharkey Site continue the work started at the Delta Experimental Forest. Their results show the feasibility of establishing a multispecies plantation that promotes rapid stand development, diverse ecological values, and multiple management objectives—the basic components of a sustainable model for restoring bottomland hardwoods in the Mississippi Delta.

FOR MORE INFORMATION:

Ted Leininger at 662–686–3154 or tleininger@fs.fed.us.

These 1 to 2-year old cottonwoods are ready to provide shelter for slower growing Nuttall oak. Grown together, they provide the structure for economical afforestation of the Lower Mississippi Valley. *(photo by Bill Lea)*

around the STATION...

Experimental Forests

1	Bent Creek	NC
2	Blue Valley	NC
3	Coweeta	NC
4	John C. Calhoun	SC
5	Santee	SC
6	Scull Shoals	GA
7	Hitchiti	GA
8	Olustee	FL
9	Chipola	FL
10	Escambia	AL
11	Tallahatchee	MS
12	Delta	MS
13	Harrison	MS
14	Palustris	LA
15	Stephen F. Austin	TX
16	Crossett	AR
17	Alum Creek	AR
18	Sylamore	AR
19	Henry F. Koen	AR

Station Director, Pete Roussopoulos

IMPETUS FOR CHANGE

The Southern Research Station has a long and productive history in the restoration and recovery of forested landscapes in the South through a longstanding and broad-based research program that addresses the many challenges of sustaining natural resources. Many of our scientists have been recognized as world leaders in forest research.

Our capacity to continue this productive history is now challenged by the forces faced by many other public research institutions in the United States, including declining budgets, the changing nature of important research questions, and shifts in customers and their expectations for research products.

Over the past decade, our organization has struggled as it has adjusted to withstand the effects of consolidation and recent budgetary shocks. Today, our science leaders face mounting administrative workloads, flat-to-decreasing budgets, and increasing costs that shrink their real decision space and complicate their ability to make strategic choices.

Our most recent configuration of 28 research units loosely reporting to three assistant directors tends to produce incremental decisions about science priorities. This model of priority setting leads to a diffuse research program, which has been extremely successful in serving the needs of southern landowners and managers. Increasingly, however, ownerships in the South are becoming even more fragmented at a time when the threats to forest sustainability demand more comprehensive approaches. We believe that change is necessary if we are to achieve a coherent science program, attract the best and brightest, and maintain science leadership in the natural resource community.

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Impetus for Change

(continued from page 37)

The New Organization

Our first step was to identify five logical groupings of scientific activities, called Science Areas, within which to organize our research units:

Forest Values—Natural resources and humans are inextricably linked in the Southern United States. These linkages will only strengthen as increased urbanization, globalization, and shifting values influence and alter how people interact with forests. **Forest Values, Uses, and Policies** will provide the knowledge and tools required to manage impacts and optimize benefits of human-forest interactions. Contact: John Kelly, 828-257-4309, jkelly@fs.fed.us.

Forest Inventory and Monitoring—Quantifying and monitoring the condition of natural resources in the Southern United States is critical for determining ecosystem responses to forest health threats and improvements in natural resource condition resulting from management activities. **Natural Resources Inventory and Monitoring** will provide the knowledge and tools required to quantify, monitor, and predict the condition of natural resources. Contact Bill Burkman, 865-862-2073, bburkman@fs.fed.us.

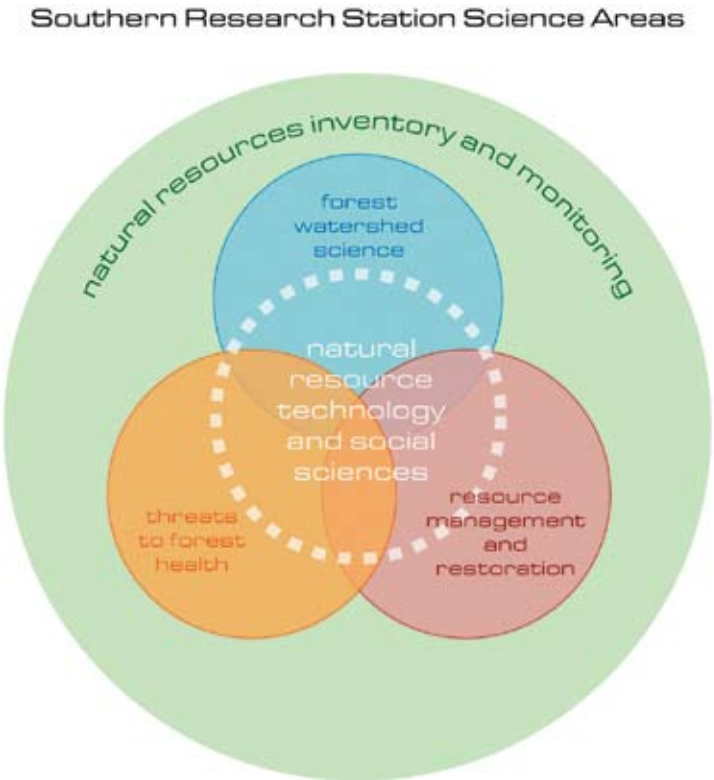
Threats to Forest Health—Forest ecosystems in the Southern United States are facing increased threats from factors such as nonnative and native insects and diseases, invasive plants and animals, wildfire, and climate change and variability. **Threats to Forest Health** will provide the knowledge and tools required to prevent, eradicate, and mitigate the impacts of forest health threats. Contact: Bruce Jewell, 828-257-4307, bjewell@fs.fed.us.

Watershed Science—Forested watersheds (uplands, wetlands, bottomlands, and their components) will be increasingly relied upon to provide clean and dependable water to support aquatic ecosystems and satisfy the demands of a rapidly growing human population in the Southern United States. **Forest Watershed Science** will provide the knowledge and tools required to manage the full range of forest watershed resources in a dynamic and complex landscape. Contact: Greg Ruark, 256-372-4540, gruark@fs.fed.us.

Restoration and Management—As the nature of private landownership changes, society's needs from public lands shift, and species, communities, and ecosystems require restoration, new options will be required for forest and wildlife management in the Southern United States. **Forest Ecosystem Restoration and Management** will provide the knowledge and tools required to manage and restore the multiple benefits provided by forests. Contact: Nancy Herbert, 828-257-4306, nherbert@fs.fed.us.

We believe that these Science Areas provide a compelling statement of who we are by defining our core research strengths. They also define broad scientific communities which share common subject matter, disciplines, and research models, thereby providing a logical structure for coordinated research planning. As shown in the graphic below, the Science Areas are multifaceted and overlapping, with humans at the center and forest inventory and analysis as a backdrop to illustrate the importance of information on current conditions, long-term trends, and the sustainability of natural resources in the South.

Once the Science Areas were adopted, our next step was to increase administrative efficiency by reducing the number of research units from 28 to approximately 15, thereby improving "critical mass" of remaining units and minimizing the research resources dedicated to administrative duties. The new units and leaders are shown on page 46.



NEXT STEPS

Over the remainder of the year, we will be revamping our administrative structure to support this new organization. We will also begin to consider how we will use the Science Areas to transform research planning into a broader, more integrated, and more inclusive process. For that, we will need the help of partners, customers, and users.

As each of the Science Areas works through questions of mission, issue identification, objectives, and problem definition, we will be looking for engagement with stakeholders to provide input and guidance, both from their unique perspectives and from their grasp of what is needed to ensure the sustainability of southern forests.

"We want to spend some quality time with other people who care about natural resources in the South," said **Pete Roussopoulos** in announcing the realignment at a recent management meeting. "We're not so interested in big public meetings as in forums and formats where we get to know each other, speak frankly, and forge long-term relationships. In this way, I believe we can build a research program that helps the South unlock its enormous potential."

If you are interested in participating in this next step, please send an email to carolwhitlock@fs.fed.us.

Bottomlands in the Lower Mississippi Alluvial Valley provide habitat for bald cypress. *(photo by Bill Lea)*

Spring at SRS Headquarters, Asheville, NC *(photo by Rodney Kindlund)*

NEW PRODUCTS

SOUTHERN PINE ECOSYSTEMS

1 Broce, Alberto B.; Zurek, Ludek; Kalisch, James A. [and others]. 2006. ***Pyemotes herfsi* (Acari: Pyemotidae), a mite new to North America as the cause of bite outbreaks.** Journal of Medical Entomology. 43(3): 610-613. (Editor's note: SRS scientist John Moser co-authored this paper.)

High incidences of red, itching, and painful welts on people in the Midwestern United States led to the discovery of a European species of mite, *Pyemotes herfsi* (Oudemans) (Acari: Pyemotidae), preying on gall-making midge larvae on oak leaves. The mites' great reproductive potential, small size, and high capacity for dispersal by wind make them difficult to control or avoid.

2 Burke, Marianne K.; Sheridan, Philip, eds. 2005. **Atlantic white cedar: ecology, restoration, and management: Proceedings of the Arlington Echo symposium.** Gen. Tech. Rep. SRS-91. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 74 p.

A symposium was held on the globally threatened and coastally restricted tree species, Atlantic white cedar (*Chamaecyparis thyoides*) in June 2003. The theme of the symposium was "Uniting Forces for Action," and participants in the symposium came from throughout the range of this species, from New England to the Gulf Coast. More than 15 papers and posters were presented, addressing topics on community and ecosystem ecology of natural Atlantic white cedar habitats, ecosystem restoration, and

stewardship efforts; the current range of the species; information on range-wide genetics; and the long-term effects of various silvicultural manipulations on the entire vegetation community in the Atlantic white cedar habitat.

3 Butnor, John R.; Johnsen, Kurt H.; Sanchez, Felipe G. 2006. **Whole-tree and forest floor removal from a loblolly pine plantation have no effect on forest floor CO_2 efflux 10 years after harvest.** Forest Ecology and Management. 227: 89-95.

Intensive management of southern pine plantations has yielded multifold increases in productivity over the last half century. The process of harvesting merchantable material and preparing a site for planting can lead to a considerable loss of organic matter. We were interested to learn whether extreme losses of organic matter would affect soil respiration (CO_2 flux back to the atmosphere), soil carbon, and tree growth 10 years after a harvest. This work was done at the Croatan National Forest, Long Term Soil Productivity site in eastern North Carolina. We found no differences in soil respiration, soil carbon content, or tree growth between a typical harvest where only the merchantable bole is harvested and a drastic treatment where the whole-tree and the organic layer of the forest floor is stripped away. Both treatments resulted in a greater quantity of soil C, indicating that the disturbance associated with harvesting enhanced soil C, at least over the short term. This demonstrates loss of organic matter in these plantations does not alter soil respiration, nor is it detrimental to forest productivity over the course of a rotation. However, over several rotations, nutrient deficiencies may be exacerbated.

4 Laves, Kevin S.; Loeb, Susan C. 2006. **Differential estimates of southern flying squirrel (*Glaucomys volans*) population structure based on capture method**. American Midland Naturalist. 155: 237-243.

Southern flying squirrels are important components of southern forest ecosystems. They are major consumers of mast, are prey for many carnivores, and negatively impact the endangered red-cockaded woodpecker by usurping its cavities. Thus, obtaining accurate estimates of southern flying squirrel population size and structure is important for effective management. We compared estimates of southern flying squirrel population size and structure using two common capture methods: Sherman live traps and cavity inspections. We found that overall trappability and trappability of various age and sex groups varied between methods and years. Our results suggest that, when possible, both trapping and nest box or cavity examinations be done to ensure unbiased estimates of southern flying squirrel population abundance and structure.

5 Ma, Siyan; Chen, Jiquan; Butnor, John R. [and others]. 2005. **Biophysical controls on soil respiration in the dominant patch types of an old-growth, mixed-conifer forest.** Forest Science. 51(3): 221-232.

California's Sierra Nevada old-growth, mixed-conifer forests are comprised of several ecological patch types, which cycle carbon in very different ways. These patches are in close proximity and vary from large forest trees (sugar pine, red fir, white fir), to nitrogen-fixing ceanothus shrubs and dry sandy patches with drought-adapted plants. To understand the factors which control seasonal losses of carbon to the atmosphere, we used portable and automated measurement systems to sample soil respiration from snow melt to mid-summer drought. The highest respiration rates were found in the shrub system, followed by the forest and bare soil patches. Using this data we developed an exponential model to calculate the total soil carbon flux summed by an area-weighted average across all three patch types for year 2000.

6 Miller, Daniel R. 2006. **Ethanol and (–)-α-pinene: attractant kairomones for some large wood-boring beetles in Southeastern USA**. Journal of Chemical Ecology. 32: 779-794.

We found that the combination of ethanol and (-)-α-pinene is attractive to numerous species of wood boring beetles in the South, such as the southern sawyer beetle and reproduction weevils. These results provide support for the use of traps baited with ethanol and (-)-α-pinene to detect and intercept common large wood-boring beetles from the Southeastern United States at ports-of-departure in the USA and overseas ports-of-entry, as well as monitor populations of woodborers in forested areas in the South.

7 Sword Sayer, Mary Anne; Brissette, John C.; Barnett, James P. 2005. **Root growth and hydraulic conductivity of southern pine seedlings in response to soil temperature and water availability after planting.** New Forests. 30: 253-272.

Advances in forestry technology have given land managers in the Southeastern United States several options regarding which pine species to plant. To guide these

decisions, we used root growth and water uptake of planted seedlings as measures of establishment success and evaluated three seed sources each of shortleaf, loblolly, and longleaf pine in response to soil temperature and moisture. Results suggest that the establishment of longleaf pine is better compared to shortleaf and loblolly pine in cool soil. When the soil is warm and moisture is not limiting, the establishment of shortleaf and loblolly pine is superior to that of longleaf pine. As soil moisture decreases, however, longleaf pine establishment may surpass that of loblolly pine. Within a species, seed source also influences establishment.

WETLANDS, BOTTOMLANDS, AND STREAMS

8 Devall, Margaret S.; Thien, Leonard B.; Ellgaard, Erik; and Flowers, George. 2006. **Lead transport into Bayou Trepagnier wetlands in Louisiana, USA.** Journal of Environmental Quality. 35: 758-765.

Establishment of a petroleum refinery in 1916 near the headwaters of Bayou Trepagnier in Louisiana, with subsequent dredging of the bayou, resulted in spoil banks (waste material removed during dredging) containing high levels of lead. Cores were taken from baldcypress trees along two transects running perpendicular from the spoil bank into a cypress-tupelo swamp. Soil samples and five year segments of the cores were prepared and analyzed for heavy metals. Levels of lead in Bayou Trepagnier swamp trees were compared to levels in baldcypress trees growing along Stinking Bayou, a nearby reference area. Baldcypress trees in the cypress-tupelo swamp soil with moderate levels of lead concentrated much more lead than trees growing on the heavily polluted bank, or trees from the reference area. Lead in the spoil bank is in a form not easily taken up by plants, but when the spoil bank soil is in contact with the brackish bayou water (during storms, flooding, hurricanes, etc.), lead is released into the water column and washed into the swamp in a form that is more available to plants.

9 Lockhart, Brian Roy; Ezell, Andrew W.; Hodges, John D.; Clatterbuck, Wayne K. 2006. **Using natural stand development patterns in artificial mixtures: a case study with cherrybark oak and sweetgum in east-central Mississippi, USA**. Forest Ecology and Management. 222: 202-210.

Results from a long-term planted mixture of cherrybark oak (*Quercus pagoda* Raf.) and sweetgum (*Liquidambar styraciflua* L.) showed sweetgum taller in height and larger in diameter than cherrybark oak early in plantation development. By age 17 years, cherrybark oak was similar in height and diameter with sweetgum, and by age 21 years was taller in height and larger in diameter than sweetgum. The ascendance of cherrybark oak above sweetgum in an intimate plantation mixture confirms results from a stand reconstruction study of cherrybark oak and sweetgum development in natural stands. Afforestation of abandoned agricultural fields in the Lower Mississippi Alluvial Valley has received much attention in the past 20 years. Concern has been expressed about planting only oaks and the resulting effects of early intra-specific competition following canopy closure.

10 Love, Joseph W.; Taylor, Christopher M.; Warren, Melvin L., Jr. 2005. **Predator density and dissolved oxygen affect body condition of *Stenonema tripunctatum* (Ephemeroptera, Heptageniidae) from intermittent streams**. Hydrobiologia. 543: 113-118.

The effects of population density, fish density, and dissolved oxygen on body condition of late-instar nymphs of *Stenonema tripunctatum* (Ephemeroptera, Heptageniidae) were investigated using nymphs sampled from isolated, upland stream pools over summer in central Arkansas, USA. All three factors exhibited high variation among pools. Body condition was negatively related to fish density, and positively related to dissolved oxygen (when included in the model). High fish densities maybe related to low body condition because they cause reduced foraging or force earlier emergence at small body sizes. These results emphasize the combined effects of biotic and abiotic factors on body condition in mayflies, and support earlier findings that population density is a less important factor.

MOUNTAIN AND HIGHLAND ECOSYSTEMS

11 Bragg, Don C. 2005. **Presettlement *Pinus taeda* in the Mississippi Valley Alluvial Plain of the Monroe County, Arkansas area**. Journal of the Arkansas Academy of Science. 59: 187-195.

Loblolly pine (*Pinus taeda*) is the most dominant conifer in the Southeastern United States. However, loblolly pine was conspicuously absent from virtually the entire Mississippi Valley Alluvial Plain during presettlement times. In that period (before 1850), this portion of Monroe County was a complex mosaic of hardwood swamps and flatwoods, scattered prairies and other openings, and occasional conifer-dominated stands. In a landscape covered with bottomland oaks, gums, hickories, other hardwoods, and baldcypress swamps, loblolly pine-dominated communities are unexpected elements of structural, functional, and compositional diversity. Thus, modern-day analogs of these loblolly pine forests are not artifacts of recent human influence, but rather self-replacing components of the ecosystem.

12 Phillips, Jonathan D.; Marion, Daniel A. 2006. **Biomechanical effects of trees on soil and regolith: beyond treethrow.** Annals of the Association of American Geographers. 96(2): 233-247.

In addition to uprooting (treethrow), forest soils in the Ouachita Mountains of Arkansas are profoundly influenced by physical displacement of soil by tree-root growth and infilling of stump rot pits. Root growth displaces soil both vertically and laterally. Infilling of stump pits occurs rapidly, includes external material as well as soil detachment from the pit walls, and results in subsurface stone accumulations. The estimated times for 100 percent of the forest floor to be affected are shortest for soil displacement, intermediate for uprooting, and longest for stump hole effects. These biomechanical processes are clearly important in explaining spatial variation in soil characteristics.

13 Simon, Steven A.; Collins, Thomas K.; Kauffman, Gary L. [and others]. 2005. **Ecological zones in the Southern Appalachians: first approximations**. Res. Pap. SRS-41. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 41 p. [Editor's note: Station scientists W. Henry McNab co-authored this publication.]

Forest environments of the Southern Appalachian Mountains and their characteristic plant communities are among the most varied in the Eastern United States. Considerable data are available on the distribution of plant communities relative to temperature and moisture regimes, but not much information on fertility as an environmental influence has been published; nor has anyone presented a map of the major, broad-scale ecosystems of the region, which could be used for planning and management of biological resources on forestlands. Our objectives were to identify predominant ecological units, develop a grouping of geologic formations related to site fertility, and model and map ecological zones of the Southern Appalachians. Results of this project suggest that bedrock geology is an important factor affecting the distribution of vegetation. The developed map is a realistic depiction of ecological zones that can be used by resource managers for purposes ranging from broad-scale assessment to local-scale project planning.

Inventory and Monitoring

14 Bentley, James W.; Lowe, Larry. 2006. **Kentucky's timber industry—an assessment of timber product output and use, 2003.** Resour. Bull. SRS-105. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 50 p.

This report contains the findings of a 2003 canvas of all primary wood-using plants in Kentucky, and presents changes in product output and residue use since 2001. It complements the Forest Inventory and Analysis periodic inventory of volume and removals from the State's timberland. The canvass was conducted to determine the amount and source of wood receipts and annual timber product drain, by county in 2003, and to determine interstate and cross-regional movement of industrial roundwood. Only primary wood-using mills were canvassed. Primary mills are those that process roundwood in log or bolt form or as chipped roundwood. Examples of industrial roundwood products are saw logs, pulpwood, veneer logs, poles, and logs used for composite board products. Mills producing products from residues generated at primary and secondary processors were not canvassed. Trees chipped in the woods were included in the estimate of timber drain only if they were delivered to a primary domestic manufacturer.

Flooded conditions are the norm in the Lower Mississippi Valley. *(photo by USDA Forest Service)*

15 Johnson, T.G.; Knight, M. 2006. **South Carolina's timber industry—an assessment of timber product output and use, 2003.** Resour. Bull. SRS-106. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 39 p.

This report contains the findings of a 2003 canvass of all primary wood-using plants in South Carolina, and presents changes in product output and residue use since 2001. It complements the Forest Inventory and Analysis (FIA) periodic inventory of volume and removals from the State's timberland. The canvass was conducted to determine the amount and source of wood receipts and annual timber product drain, by county, in 2003 and to determine interstate and cross-regional movement of industrial roundwood. Only primary wood-using mills were canvassed. Primary mills are those that process roundwood in log or bolt form or as chipped roundwood. Examples of industrial roundwood products are saw logs, pulpwood, veneer logs, poles, and logs used for composite board products. Mills producing products from residues generated at primary and secondary processors were not canvassed. Trees chipped in the woods were included in the estimate of timber drain only if they were delivered to a primary domestic manufacturer.

LARGE-SCALE ASSESSMENT AND MONITORING

16 Liu, Yongqiang. 2005. **Enhancement of the 1988 Northern United States drought due to wildfires.** Geophysical Research Letters. 32(10): 1-4.

Drought provides a favorable environment for the ignition and spread of intense wildfires. This study examines the opposite relationship between the two natural disasters, that is, the role of wildfires in the development of drought. The case of the 1988 Northern United States wildfires is investigated. Emissions of smoke particles from the wildfires and the resulting optical depth are estimated using wildfire data and empirical algorithms. Radiative forcing of the smoke particles and atmospheric response are simulated using a regional climate model. It is found that absorption of solar radiation by smoke particles weakens the North America trough in the middle latitudes, which is a major generator of precipitation in the Midwest. Rainfall in this region is therefore reduced, providing evidence for the role of wildfires in enhancing drought.

17 Prestemon, J.P.; Wear, D.N.; Holmes, T.P.; Stewart, F. 2006. **Wildfire, timber salvage, and the economics of expediency.** Forest Policy and Economics. 8(3): 312-322.

Federally required administrative planning rules and legal challenges can have significant economic impacts on timber salvage programs on public lands. We examined the costs of the delay in timber salvage caused by planning rules and the costs associated with the volume reductions forced by legal challenges in the case of post-fire timber salvage on the 2000 Bitterroot National Forest in the northern Rocky Mountains in the United States. Our analysis showed that the legal challenge to the salvage plan, reducing available timber salvage by two-thirds, resulted in an $8.5 million loss to the U.S. treasury and an $8.8 million net loss to producers and consumers. We also found that the delay in timing of salvage initiation resulted in a net loss, after accounting for the overall reduction in the size of the salvage plan, of about 25 percent in timber receipts for the government and about 25 percent in timber market benefits.

Aerial view of the Mississippi River Delta. *(photo courtesy NASA)*

WILDLAND URBAN INTERFACE AND URBAN FORESTRY

18 Reams, Margaret A.; Haines, Terry K.; Renner. 2005. **The national database of wildfire mitigation programs: state, county, and local efforts to reduce wildfire risk** [CD-ROM]. In: Proceedings of the 2004 Society of American Foresters National Convention: One Forest under Two Flags. Bethesda, MD: Society of American Foresters.

The growth of residential communities within forested areas has increased the danger to life and property from uncontrolled wildfire. In response, states, counties and local governments in the United States have dramatically increased their wildfire mitigation efforts. Policymakers and fire officials are employing a wide range of regulatory and voluntary wildfire risk reduction programs. We researched wildfire hazard mitigation programs developed by state and local governments to establish the website, http://www.wildfireprograms.usda.gov. The Web site is a clearinghouse of information to assist wildfire protection officials, community leaders, and policy makers in the development of effective wildfire mitigation strategies. The site currently describes more than 190 programs in 31 States, and includes information about the purpose, features, and accomplishments of wildfire hazard mitigation efforts, as well as links to pertinent Web sites and program managers' contact information.

19 Reams, Margaret A.; Haines, Terry K.; Renner, Cheryl R. [and others]. 2005. **Goals, obstacles, and effective strategies of wildfire mitigation programs in the wildland-urban interface.** Forest Policy and Economics. 7: 818-826.

The dramatic expansion into the wildland–urban interface places property, natural assets, and human life at risk from wildfire destruction. The United States National Fire Plan encourages communities to implement laws and outreach programs for pre-fire planning to mitigate the risk to area residents. A survey of regulatory and voluntary wildfire risk reduction program administrators suggests several new insights about risk mitigation efforts, including 1) how they are organized, 2) what they are trying to accomplish, 3) what the obstacles are, and 4) how well they may be working. We describe the goals and objectives of these programs, as well as the obstacles confronting managers. We explore trends in these programs, including participation in collaborative planning, use of program evaluation to measure progress toward goals, and program managers' perceptions of their most effective programs for creating defensible space.

FOUNDATION PROGRAMS

20 Connor, Kristina F., ed. 2006. **Proceedings of the 13th biennial southern silvicultural research conference.** Gen. Tech. Rep. SRS-92. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 640 p.

A range of issues affecting southern forests are addressed in 109 papers and 39 poster summaries. Papers are grouped in 14 sessions that include wildlife ecology; pine silviculture; longleaf pine; nutritional amendments; vegetation management; site preparation; hardwoods: artificial regeneration; hardwoods: midstory competition control; growth and yield; water quality; forest health; fire; hardwoods: natural regeneration; and hardwood intermediate treatments.

21 Kingsolver, John M.; Stephan, Karl; Moser, John C. 2006. **A new species of *Lasconotus* (Coleoptera: Colydiidae) from Arizona and South Dakota.** U.S.A. Entomological News. 117(1): 53-56.

Lasconotus fitzgibbonae, a new species in the Colydiidae, is described. It is compared with *Lasconotus coronatus* (Hinton) from Mexico, originally described in the genus *Chrysopogonius* Hinton, now a synonym of *Lasconotus* Erichson. The South Dakota specimens were found under the root bark of *Pinus edulis* Engelm.

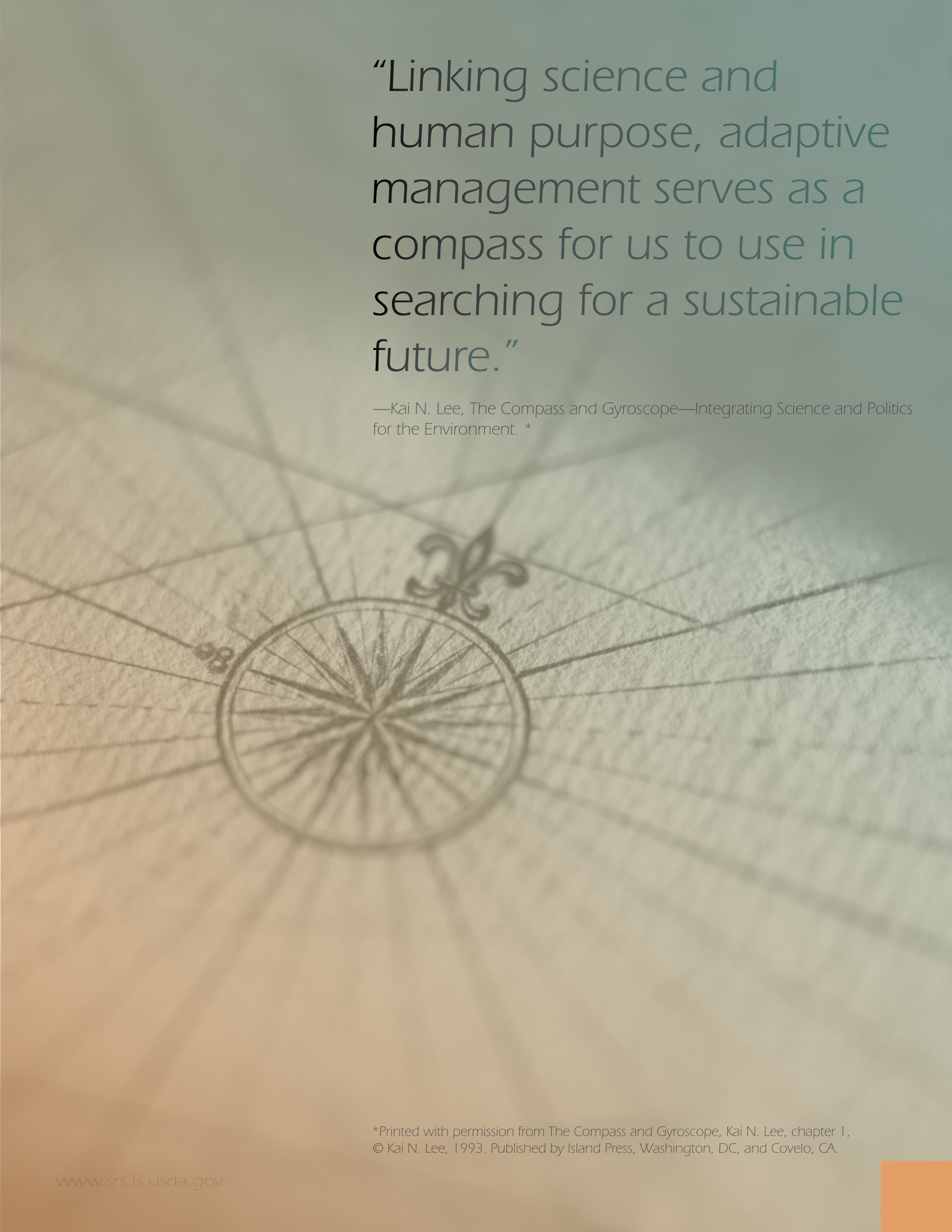
22 Selgrade, James F.; Roberds, James H. 2005. **Results on asymptomatic behaviour for discrete, two-patch metapopulations with density-dependent selection.** Journal of Difference Equations and Applications. 11(4-5): 459-476.

A 4-dimensional system of nonlinear difference equations tracking allele frequencies and population sizes for a two-patch metapopulation model is studied. This system describes intergenerational changes brought about by density-dependent selection within patches and moderated by the effects of migration between patches. To determine conditions which result in similar behavior at the level of local populations, we introduce the concept of symmetric equilibrium and relate it to properties of allelic and genotypic fitness. We present examples of metapopulation stability, instability, and bistability, as well as an example showing that differentially greater migration into a stable patch results in metapopulation stability. Finally, we illustrate a Naimark-Sacker bifurcation giving a globally asymptotically stable invariant curve for the 4-dimensional model.

Sunset on the river.
(photo by USDA Forest Service)

RESEARCH WORK UNITS

Location & Project Leader	Name & Web Site	Phone
Forest Ecosystem Restoration and Management		
Asheville, NC David Loftis	Upland Hardwood Ecology & Management www.srs.fs.usda.gov/bentcreek	828-667-5261
Auburn, AL Kris Connor	Restoring Longleaf Pine Ecosystems www.srs.fs.usda.gov/4111	334-826-8700
Monticello, AR James Guldin	Southern Pine Ecology www.srs.fs.usda.gov/4106	870-367-3464
Saucier, MS Dana Nelson	Genetics and Foundations of Productivity www.srs.fs.usda.gov/organization/unit/mississippi.htm#SRS-4153	228-832-2747
Forest Values, Uses, and Policies		
Athens, GA Ken Cordell, acting	Urban and Social Influences www.srs.fs.usda.gov/trends	706-559-4263
Auburn, AL Bob Rummer	Forest Operations www.srs.fs.usda.gov/forestops/	334-826-8700
Pineville, LA Les Groom	Characterization and Properties of Wood www.srs.fs.usda.gov/4701	318-473-7268
Research Triangle Park, NC David Wear	Forest Economics and Policy www.srs.fs.usda.gov/econ	919-549-4093
Threats to Forest Health		
Asheville, NC Danny Lee	Eastern Forest Environmental Threat Assessment Center www.srs.fs.usda.gov/cc/threatassessment.htm	828-257-4854
Athens, GA John Stanturf	Disturbance Ecology http://srs.fs.usda.gov/disturbance	706-559-4316
Pineville, LA Kier Klepzig	Insects, Diseases, and Invasive Plants of Southern Forests www.srs.fs.usda.gov/4501	318-473-7232
Forest Watershed Science		
Franklin, NC Jim Vose	Forest Watershed Science www.srs.fs.usda.gov/coweeta	828-524-2128
Lincoln, NE Michele Schoeneberger	National Agroforestry Center www.nac.gov	402-437-5178
Stoneville, MS Ted Leininger	Bottomland Hardwoods www.srs.fs.usda.gov/cbhr	662-686-3154
Natural Resources Inventory and Monitoring		
Knoxville, TN Bill Burkman	Forest Inventory and Analysis www.srsfia2.fs.fed.us	865-862-2000



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—Kai N. Lee, The Compass and Gyroscope—Integrating Science and Politics for the Environment. *

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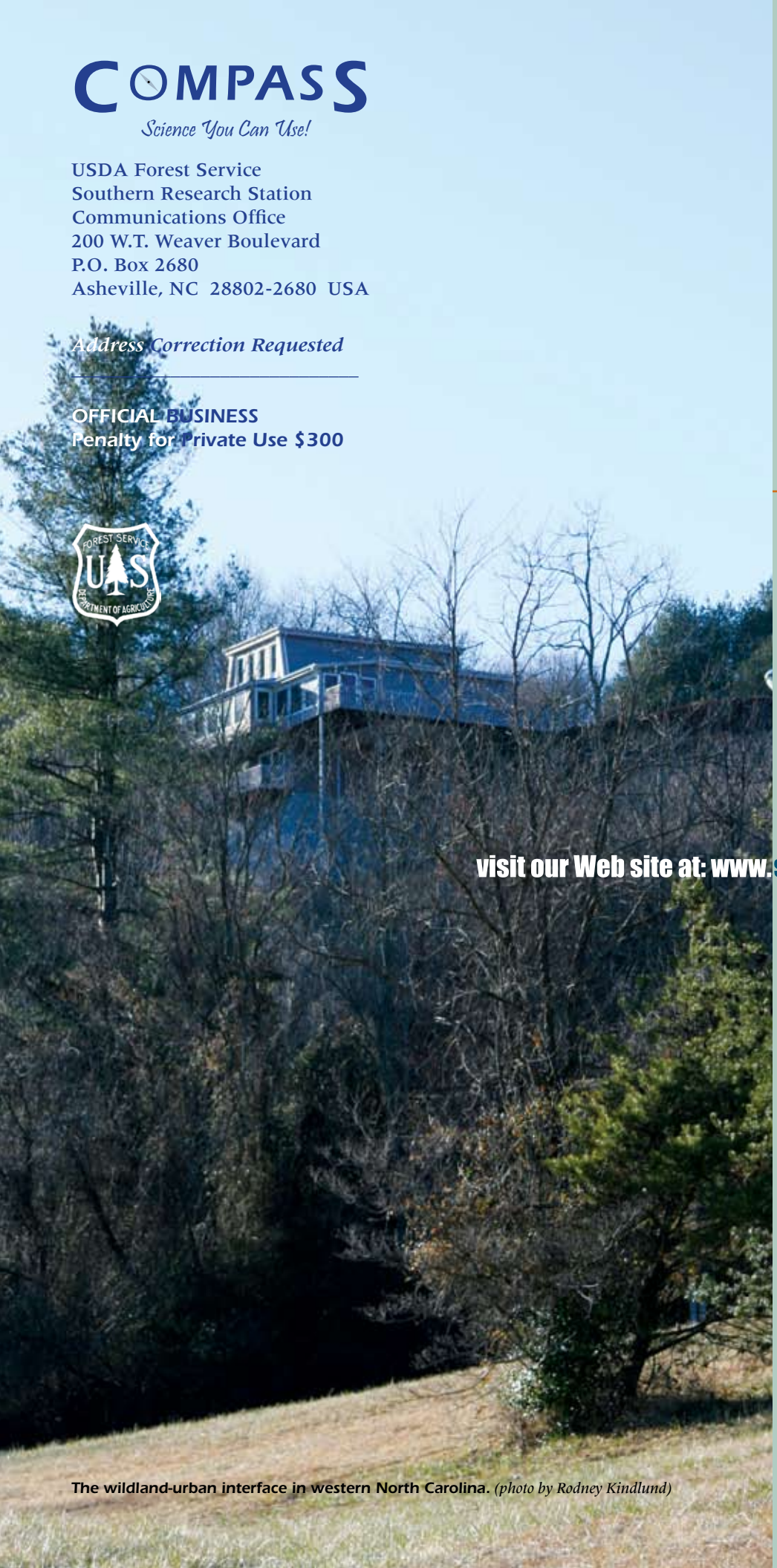

The wildland-urban interface in western North Carolina. *(photo by Rodney Kindlund)*

Next Issue...

In the next issue of Compass, we travel from the bottomland hardwood forests of the Lower Mississippi Alluvial Valley to the wildland-urban interface, that ubiquitous place where human development mingles with forests and other undeveloped lands. Issues at the interface include: fire, watershed health and management, land use planning and policy, wildlife conservation and management, and many more. We will define the interface from different perspectives, and offer an array of practical solutions developed by SRS scientists and their cooperators.

Ask A Scientist...

- Do you have a question you would like to ask about the wildland-urban interface?
- Email your question to cpayne@fs.fed.us
- We will feature one of your questions—with answers from our scientists—in our next issue.

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